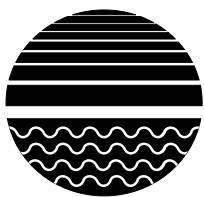


Sustainable Development of Tropical Australia:

**R&D for Management of Land,
Water and Marine Resources**



**Land & Water
Resources**
Research &
Development
Corporation



CSIRO



**F I S H E R I E S
R E S E A R C H &
D E V E L O P M E N T
C O R P O R A T I O N**

Published by: Land and Water Resources Research and Development Corporation
GPO Box 2182
Canberra ACT 2601
Telephone: (02) 6257 3379
Facsimile: (02) 6257 3420
Email: public@lwrrdc.gov.au
WebSite: www.lwrrdc.gov.au

© LWRRDC

Disclaimer: The information contained in this publication has been published by LWRRDC to assist public knowledge and discussion and to help improve the sustainable management of land, water and vegetation. Where technical information has been prepared by or contributed by authors external to the Corporation, readers should contact the author(s), and conduct their own enquiries, before making use of that information.

Publication data: 'Sustainable Development of Tropical Australia: R&D for Management of Land, Water and Marine Resources', A.K.L. Johnson, S.G. Cowell, G. Dews, N.R. Loneragan and I.R. Poiner, LWRRDC Occasional Paper 05/99.

Authors:	Andrew Johnson* CSIRO Tropical Agriculture 306 Carmody Road St Lucia Brisbane QLD 4067 Telephone: (07) 3214 2200 Facsimile: (07) 3214 2288 Email: andrew.johnson@cnetns.tcp.csiro.au	Stuart Cowell CSIRO Tropical Agriculture PMB PO Aitkenvale QLD 4814 Telephone: (07) 4753 8507 Facsimile: (07) 4753 8600 Email: stuart.cowell@tag.csiro.au
	Dr Neil Loneragan CSIRO Marine Research PO Box 120 Cleveland Brisbane QLD 4163 Telephone: (07) 3826 7223 Facsimile: (07) 3826 7222 Email: neil.loneragan@marine.csiro.au	Geoff Dews CSIRO Marine Research PO Box 120 Cleveland Brisbane QLD 4163 Telephone: (07) 3826 7223 Facsimile: (07) 3826 7222 Email: geoff.dews@marine.csiro.au
	Dr Ian Poiner CSIRO Marine Research PO Box 120 Cleveland Brisbane QLD 4163 Telephone: (07) 3826 7223 Facsimile: (07) 3826 7222 Email: ian.poiner@marine.csiro.au	

*To whom enquiries should be directed

ISSN 1320-0992

ISBN 0 642 26751 0

Edited by: Arawang Communication Group

Printed by: Expo Document Copy Centre

May 1999

Executive Summary and Recommendations

In May 1998, CSIRO Marine Research and Tropical Agriculture were commissioned by the Fisheries Research and Development Corporation (FRDC) and the Land and Water Resources Research and Development Corporation (LWRRDC) to undertake a six-month scoping study to examine opportunities for the development of research proposal(s) aimed at supporting the sustainable development of land, water and marine resources in tropical Australia. The study region extends westwards from the Cape York Peninsula to the Broome region in Western Australia.

The terms of reference for the study were to:

- Identify regional stakeholders and document their key resource management issues and research and development (R&D) priorities.
- Undertake a data and information review that:
 - develops a meta-database for available regional data.
 - determines information needed to support management.
 - outlines planned development(s).
 - summarises current legislative, jurisdictional and institutional boundaries documenting the scales of management needed.
 - summarises existing planning processes.
 - identifies the key aquatic resources and key catchment areas.
- Document the activities, skills and resources of research providers.
- Consider the spatial extent (ie. location and scale) of a potential study (s).
- Develop research proposal(s) aimed at supporting the sustainable development of land, water and marine resources in tropical Australia.
- Consider ways of approaching an integrated multidisciplinary study (s) and identify potential obstacles and risks to research projects.

This scoping study builds on a workshop held at CSIRO Marine Research, Cleveland, in September 1997 to consider issues for the sustainable development of marine resources in northern Australia, and on two major reports: one to the former Meat Research Corporation (now Meat and Livestock Australia) on the impacts of grazing in northern catchments; the other to the FRDC on the R&D needs for marine habitats to sustain fisheries production. However, this study differs from previous work by being an integrated attempt to address the question of natural resource use from land to sea. It is also unique in its approach, which involved interviews of stakeholders (85 people from 61 organisations) and a review of the literature from the terrestrial through to the marine environment. In addition to technical questions, we also considered the effectiveness of institutions, and the capacity of regional stakeholders to support the planning and management of natural resources. We also substantively incorporate Indigenous issues and needs within this review

Data and Information Review (Chapters 2–4)

A desktop review of the published literature was used to augment interview material and to help identify the biophysical, social, institutional and economic characteristics of the study area. Departmental reports, planning studies and research publications were also reviewed. In addition, a meta-database of key digital data available for the region was constructed and is available on the study webpage <<http://irum.tag.csiro.au/nassis>>. In reporting key themes and issues from the literature, we have classified our results into three categories—integrated resource management, planning systems and Indigenous resource management.

Integrated Resource Management

Seven key issues emerge, both nationally and internationally. These are:

- There is a clear need for natural resource planning and management to focus at multiple spatial and temporal scales.

-
- The importance of addressing the relevance of social context and diversity in values within planning and management.
 - There is a clear need for coordination of planning and management functions within and between resource management organisations.
 - The need for decision-making to integrate planning and management across terrestrial and marine environments.
 - The critical importance of negotiation and conflict-resolution strategies for future natural resource planning and management activities.
 - The need for active and effective community involvement in planning and management activities.
 - The need to enhance transfer of information between researchers, managers and key stakeholders across catchment, estuary and marine systems.

Planning Systems

We argue that three core elements are required to develop and implement effective planning systems: sound technical information, effective institutional arrangements and strong stakeholder capacity. Within each of these core elements, several issues emerge from the literature.

Technical

- It is critical that any natural resource planning and management activities be effectively underpinned by high quality technical support.
- Increasing development pressure is occurring in tropical Australia within a context of poor data availability (especially in the marine environment), and a lack of data at a scale relevant to planning and management needs.
- While some baseline data are available, process understanding in terrestrial, aquatic and marine systems is extremely poor. Where process understanding exists, it is usually at plot, point or plant community scale.
- Natural resource planning and management is fundamentally constrained by the paucity of social, economic, and ecological data.

Institutional

- With a few exceptions, there is a lack of coordination/integration of institutions and institutional arrangements at regional scale in tropical Australia.
- Present arrangements do not facilitate broad stakeholder representation/participation in regional decision-making.
- In most jurisdictions, there appears to be strong political resistance to Indigenous aspirations being addressed in mainstream natural resource planning and management activities.
- Current arrangements impede the ability of many stakeholders to effectively participate in planning processes.
- There is a clear need for appropriate/representative institutional structures to facilitate regional planning in tropical Australia.

Capacity

- Limits on available human and financial resources provide a critical impediment to effective planning and management in tropical Australia. In addition, it is difficult to attract high quality staff, once recruited there is generally a low retention or transfer of skills to the region and those who remain generally have a narrow range of skills to deploy.
- Given the size of the region and its remote location from major centres of population, the costs of undertaking effective R&D are in many cases prohibitive.
- In order to establish the necessary preconditions for R&D to support effective planning and management, there is an urgent need for capacity development in all stakeholder groups.

Indigenous Resource Management

Given the importance of Indigenous interests to the study area, we have also highlighted issues specific to Indigenous resource management themes and issues. Key issues include:

- Indigenous peoples have to date largely been marginalised in economic and natural resource planning, management and decision-making, despite the demographic reality of tropical Australia.
- There is a lack of effective recognition of Indigenous aspirations and rights in resource management in the region, particularly the lack of incorporation of Native Title into broad land use objectives.
- Indigenous communities and agencies are poorly resourced for participation in planning and management processes.
- There has been poor integration of Indigenous peoples' knowledge in resource planning and management practice, in part due to a lack of appropriate mechanisms to do so.
- Stakeholders identified the need for parity between Indigenous tenure systems and agency management boundaries, or recognition of the distinction between them at a management and jurisdictional level.
- The need to address social and community issues within a natural resource planning and management context.
- There is a need for development of multiple use strategies on Indigenous controlled land so as to achieve viability in landowners terms.
- The need for capacity building to assist in planning and management was seen to be urgent among Aboriginal landowners.
- The lack of cohesion between State, Territory and Commonwealth agencies on Indigenous resource management issues remains a serious constraint.

A full discussion of planned development; legislative, jurisdictional and institutional boundaries; and planning processes is provided in the main text (Chapters 2, 3 and 4).

Research Capacity

To date there has been a comparatively small investment of R&D in the study region, with the consequence that, relative to the rest of Australia, R&D effort in the study region is slight. With rapidly increasing development pressure in the region, there exists a unique opportunity to have a substantial positive impact on any future resource use through the development and application of high quality science. There is a growing R&D capacity within the study region, particularly with the emergence of organisations such as the CRC for the Sustainable Development of Tropical Savannas and the Centre for Indigenous Natural and Cultural Resource Management. Significant potential R&D capacity exists within agencies such as CSIRO, the Queensland Department of Natural Resources, the Australian Institute of Marine Science, James Cook University, the Australian National University, the University of Western Australia, the CRC for Sustainable Sugar Production and the CRC for Sustainable Development of the Great Barrier Reef, which currently have resources deployed in Brisbane, Townsville, Rockhampton, Perth and Canberra.

Stakeholder Perspectives (Chapter 5)

Northern Australia covers a vast area that is sparsely populated but has some regions where the population is growing very rapidly. It has a higher proportion of Indigenous peoples in the population than most regions of Australia. These characteristics lead to some common issues that were identified in our interviews with stakeholders in all three States:

- Lack of knowledge on the ecology of terrestrial, aquatic and marine systems for planning and management
- Need for improved management of feral animals, fire and introduced plants and weeds
- Lack of a strategic planning framework for development
- A need for integrated approaches to resource management
- A need for improved access to existing information on natural resources

-
- A need for integrated approaches to resource management, improved resource management information and the need to address Indigenous resource management issues
 - Limited capacity within organisations, and limited human and financial resources, for the planning and management of natural resources.

Specific issues for each State and the Commonwealth are presented in the main report.

R&D Priorities

A large number of R&D priorities were identified through an examination of the published literature and from stakeholder responses. Seven key priorities with broad relevance to the study area were identified:

- *Resource inventory* – there is a clear need to improve baseline technical information at a relevant scale if sustainable development of the region is to occur. Key areas for improvement include ground and surface hydrology, aquatic biology and ecology, landscape ecology and fisheries biology.
- *Process understanding* – the capacity to assess the ecological impacts of resource development in the region is constrained by the lack of process understanding at a relevant scale within and between terrestrial, aquatic and marine ecosystems. In particular, understanding the impacts of land and water management on marine systems was seen as critical.
- *Social, cultural and economic data/understanding* – while some technical information is available, very little is formally known about the key economic, social and cultural processes driving natural resource use in the region.
- *Integration* – mechanisms and tools to integrate and make accessible data, knowledge and understanding within the region are required to support planning and management activities.
- *Participation* – research into best practice for participatory planning in rural regions was seen as essential in ensuring more effective planning and management processes in the future. In particular, stakeholders saw a strong need to develop innovative methods and approaches for developing stakeholder capacity in rural and remote regions.
- *Institutions* – institutional failure was uniformly viewed as a key impediment to effective and equitable natural resource planning and management in the region. Stakeholders saw a key R&D opportunity in developing and evaluating alternative institutional arrangements.
- *Capacity* – lack of human and financial capacity was seen as a fundamental constraint to effectively delivering R&D for sustainable natural resource management in the region.

Location and Scale of Future Research & Development (Chapter 6)

Resulting from the desktop analysis and perceptions gained from interviews with regional stakeholders, nine terrestrial–marine regional pairings were identified as potential sites for future R&D. These broad regions were Broome–Roebuck, Fitzroy–King Sound, North Kimberley, Ord–Bonaparte, Victoria–Bonaparte, Katherine Daly–Bonaparte, Darwin Region, Southern Gulf of Carpentaria, and Western Cape York Peninsula. All regions were then evaluated on the basis of four categories (Technical Issues, Institutional Arrangements, Research Capacity and Marine Threats) to assess their potential for R&D to improve the management and planning of natural resource use. From this analysis, five regions were considered to have the highest potential for future R&D, with the Ord–Bonaparte region in the Kimberley of WA having the greatest potential for future R&D to improve integrated resource planning and management. Other regions, such as the Fitzroy–King Sound, Katherine/Daly–Bonaparte, Western Cape York, Southern Gulf of Carpentaria and Victoria–Bonaparte, also offer significant potential. The Ord–Bonaparte offers the greatest opportunity for future investment for the following reasons.

- There is significant stakeholder support (both expressed and perceived) for R&D provider involvement in the region, both locally and at State level.
- Within northern Australia, the Ord–Bonaparte represents a unique range of ecosystems and land use interactions, and therefore provides a possible model for evaluating impacts of future similar developments in other regions. This, in conjunction with proposed large scale expansion of irrigation in Ord Stage 2, current commercial fishing effort in the Joseph Bonaparte Gulf, substantial and increasing growth in the

tourism sector and rapidly increasing Indigenous control of pastoral and coastal land, make the system highly attractive for R&D investment.

- Different stakeholders already appear to be prepared to work together toward a sustainable regional future. This extends to a far greater level of Indigenous peoples' involvement than is otherwise seen in tropical Australia (with the exception of Cape York Peninsula).
- To date there has been a comparatively small investment of R&D in the Kimberley. With rapidly increasing development pressure in the region there is a unique opportunity to have a substantial positive impact on any future resource use through the application of high quality science.

Research Proposals (Chapters 7 and 8)

From our review of the literature and synthesis of stakeholder responses, seven potential strategic R&D areas were identified. We consider that five of these have high priority:

1. **Improving natural resource planning and management capacity in the Kimberley region** – a study focused on assisting stakeholders in the Kimberley region to improve their capacity to participate in natural resource planning and management through the development of innovative tools, methods and processes.
2. **Improving institutional arrangements for natural resource management and planning in the Kimberley region** – a study which aims to assess the institutional arrangements impacting on efficient, equitable and sustainable natural resource planning and management in the Kimberley. It would identify strengths and weaknesses in current arrangements and develop and evaluate alternative approaches.
3. **Impacts of natural resource use on ground and surface waters of the Ord River catchment** – a study focusing on the impacts of resource use on sediment generation, nutrient movement, water flow and other contaminant flux of ground and surface waters at scales ranging from farm to catchment.
4. **Impacts of natural resource use in the Ord River catchment on the marine resources of the Joseph Bonaparte Gulf** – a study focusing on the impacts of resource use on sediment, nutrient, water and other contaminant fluxes from ground and surface waters at catchment scale to the adjacent marine environment, marine habitats and fisheries.
5. **Integrated planning and management of land water and marine resources in the Ord–Bonaparte region** – a major integrated R&D effort aimed at linking current and new knowledge to inform and underpin the development and implementation of negotiated approaches to natural resource planning and management.

Our highest priority is for Research Proposal 5, which integrates the preceding 4 proposals. Research Proposals 1, 2, 3 and 4 are intended as stand-alone activities.

In addition, two other research proposals were identified that are worthy of consideration, but of lower immediate priority:

- (a) **Climate variability in the Kimberley region: impacts and options for the Ord–Bonaparte region** – a study assessing the potential, social, economic and biophysical impacts of climate variability in the Kimberley.
- (b) **Sustainable development of Kimberley tourism: impacts and options for the Ord–Bonaparte region** – a study to assess the potential social, economic and ecological impacts of tourism growth in the Kimberley.

Research Coordination and Potential R&D Management Models (Chapter 7)

All the research options specified involve the formation of multidisciplinary teams. Five management structures for research and development, representing a diverse range of current multidisciplinary R&D management models were evaluated. In addition, a sixth model was created from the best features of the other five models, and also evaluated. The six models of R&D development were then evaluated using eight State Principles and six Process Principles (see Chapter 7 for details). The results of the evaluation were then used to specify preferred R&D management models for the seven potential strategic R&D options.

The R&D needs of the Ord–Bonaparte region occur at two levels: what might be seen as technical (eg. groundwater modelling) and what can be seen as integrative. While it is vital that the technical work be undertaken, it should be done in a coordinated way that responds to both individual and regional stakeholder needs. Future R&D requires a detailed understanding of management needs and an overall framework for systems synthesis and integration. This will allow the results of the R&D to contribute significantly to natural resource planning activities in the region.

The R&D options proposed will require the development of funding consortia and research partnerships. These consortia must necessarily involve government, industry and community stakeholders. We favour the development of project-specific partnerships that build on existing structures and mechanisms rather than developing new ones (eg. a CRC). Within the Kimberley, stakeholders who could contribute to potential R&D consortia and partnerships could include the Kimberley Development Commission, the Kimberley Land Council, the Northern Land Council, the Kimberley Aboriginal Pastoralists Association, the WA Water & Rivers Commission, Agriculture WA, the Ord Irrigation Cooperative, the Shire of Wyndham–East Kimberley, Wesfarmers/Marubeni, the WA Pastoralists and Graziers Association, the WA Department of Resources Development, the WA Ministry for Planning, the WA Department of Environment Protection, the WA Department of Commerce and Trade, the NT Department of Primary Industry and Fisheries, the NT Lands Planning and Environment, WA Conservation and Land Management, the WA Tourism Commission, Environs Kimberley, CINCRM, the CRC for Sustainable Development of Tropical Savannas, the Australian Institute of Marine Science, consultants (eg. HG Gardiner and Associates), Rio Tinto Ltd and CSR Ltd. CSIRO Divisions with a capacity to participate include Marine Research, Tropical Agriculture, Land and Water, Maths and Information Sciences, Wildlife and Ecology, Building, Construction and Engineering, Plant Industry, Atmospheric Research, Energy Technology, Minerals, and Entomology.

We argue that any major new R&D investment in the Kimberley region will require a significant enhancement of resident R&D in Kununurra. While skills and expertise can be drawn from Darwin, Perth, Brisbane, Townsville and Canberra, improved resident R&D capacity will be essential for the successful conduct of any integrated R&D in the region. This view has been strongly supported by stakeholder feedback to earlier drafts of this report.

Recommendations

Recommendation 1: LWRDC and FRDC publish the results of the Scoping Study as a LWRDC Occasional Paper. This study is unique in terms of its integrated consideration of terrestrial and marine natural resources, and the approach it used. It has evaluated not only technical issues for research, but also considered issues of institutional effectiveness and capacity. Indigenous peoples' issues have also been considered. The broad consideration of natural resource use and management has been used to identify a focus region and make recommendations on priorities for research and development to improve the planning and management of natural resources in the region.

Recommendation 2: The focus of future R&D should aim to address integrated natural resource planning and management issues at the regional scale (eg. whole of catchment and marine bioregions).

Recommendation 3: That significant new R&D investment relating to natural resource management in northern Australia be focused on the Kimberley, with special emphasis on the Ord–Bonaparte region.

Recommendation 4: A participatory planning systems approach based on sustainability, equity, accountability and integration represents the most appropriate and viable conceptual underpinning for R&D in the Kimberley region.

Recommendation 5: Future R&D relating to natural resource management in the Kimberley should focus on the development and implementation of an integrated package of research as specified in Research Proposal 5 (see above). This proposal provides a major integrated R&D effort aimed at bringing together current and new knowledge to inform, develop and implement negotiated approaches to natural resource planning and management. It combines the core elements of component R&D relating to institutions, stakeholder capacity and technical information.

Recommendation 6: LWRRDC and FRDC, in partnership with CSIRO, seek to facilitate negotiations with stakeholders in the Kimberley region to develop a multi-agency research and development consortium to fund and manage the development and implementation of Research Proposal 5 in the Ord–Bonaparte region. Seed funding for this activity could be provided by LWRRDC, FRDC, CSIRO and the governments of WA and the NT.

Recommendation 7: If Kimberley stakeholders, R&D providers and R&D funders are unable to negotiate an integrated package of research, LWRRDC and FRDC where appropriate should encourage implementation of component R&D as specified in Research Proposals 1, 2, 3 and 4.

Recommendation 8: We recommend the development of project specific partnerships that build on existing structures and mechanisms rather than developing new ones.

Recommendation 9: Successful implementation of any integrated R&D effort in the Ord–Bonaparte will require the development of an enhanced R&D capacity that is resident in the Kimberley (probably at Kununurra). While some researchers will be based in other locations, for the long-term success of the project, a critical mass of R&D personnel should be located in the region for the life of the project.

Contents

Executive Summary and Recommendations	i
List of Figures	x
List of Tables	xi
Acronyms and Abbreviations Used	xii
1 Introduction	1
1.1 Background and Rationale	1
1.2 Aims and Objectives.....	2
1.3 Methodology	2
1.4 Report Structure.....	2
2 Integrated Resource Management — Key Issues	5
2.1 Integrated Resource Management.....	5
2.2 Planning Systems.....	6
2.3 Aboriginal Involvement in Resource Management.....	10
2.4 Summary	11
3 Tropical Australia: Background	12
3.1 Description of Study Region	12
3.2 Resource Management Issues	26
3.3 Institutional Arrangements	30
4 Research and Development, and Natural Resource Information	56
4.1 Research and Development	56
4.2 Natural Resource Information.....	72
5 Stakeholder Perspectives	76
5.1 Introduction	76
5.2 Stakeholder Issues and Information Needs.....	76
5.3 Stakeholder Research and Development Priorities	86
5.4 Summary—A Regional Perspective	87
6 Identifying a Geographic Focus for Research and Development in Tropical Australia	89
6.1 Introduction.....	89
6.2 Analysis of Regions	91
6.3 Summary	102
7 Towards a R&D Response in Tropical Australia	103
7.1 Introduction.....	103
7.2 Conceptual Approach for Future Research and Development	103
7.3 Strategic Research Objectives.....	106
7.4 Integrated R&D Proposals.....	113
7.5 Models for R&D Management.....	116
7.6 Summary	123
8 Conclusions and Recommendations	124
8.1 Publication of the Scoping Study Report.....	124
8.2 Scale of R&D	124
8.3 Location of R&D	125
8.4 Research & Development Activities.....	125
8.5 Research Coordination	128
8.6 Other Issues.....	129
8.7 Summary of Recommendations and Conclusions.....	130
Bibliography	131
Appendix A – Agencies Consulted	141
Appendix B – Guiding Questions for Stakeholder Interviews	143
Appendix C – Non Resident R&D	145

List of Figures

Figure 1. Study area boundary	4
Figure 2. Interim Terrestrial and Marine Biogeographical Regions of Australia and Interim Marine and Coastal Regionalisation for Australia within the study area.	14
Figure 3. North and south Australia	15
Figure 4. Land tenure in the study area.	19
Figure 5. Applications for Native Title determinations in the study area	20
Figure 6. Proposed resource development in the study area.	27
Figure 7. Relationship between local, State and Commonwealth governments	46
Figure 8. Selected integrated regional planning processes impacting on the study area.....	52
Figure 9. Potential regions for R&D.	90
Figure 10. Vulnerability to soil erosion of key catchments in study area.	92
Figure 11. The predominant model of decision-making on ecological sustainability in the Kimberley.....	103
Figure 12. The suggested model for more effective decision-making to ensure ecologically sustainable development in the Kimberley region.....	104
Figure 13. The predominant model of R&D in natural resource planning and management in Australia.....	104
Figure 14. The suggested R&D model to support ecologically sustainable development in the Kimberley region.	105
Figure 15. R&D Management Model 1 – Southern Metropolitan (Perth) Coastal Waters Study.	116
Figure 16. R&D Management Model 2 – Central Highlands Regional Resource Use Planning Project.....	117
Figure 17. R&D Management Model 3 – North West Shelf Marine Environmental Management Study.....	118
Figure 18. R&D Management Model 4 – Catchment Management, Water Quality and Nutrient Flows in the Northern Beef Industry Study.	119
Figure 19. R&D Management Model 5 – Improved Integrated Resource Management in the Queensland Sugar Industry Study (QSIS).	120
Figure 20. R&D Management Model 6 – Sustainable Development of the Kimberley Region: R&D for Integrated Planning and Management of Land, Water and Marine Resources Study (new model).....	121

List of Tables

Table 1. Terrestrial and marine bioregions within the study area	12
Table 2. Broad population characteristics of study area in 1996.	15
Table 3. Population growth in the study region	16
Table 4. Population density in the study area.....	16
Table 5. Employment by industry type	17
Table 6. Land tenure in the study region.....	18
Table 7. Estimated value of key terrestrial industries in the study region.....	21
Table 8. Summary of important marine species, their value, fished areas, management plans and gaps in knowledge.....	23
Table 9. Key issues relating to natural resource planning and management in tropical Australia as identified in published literature.....	28
Table 10. Agency roles and responsibilities in Western Australia.....	36
Table 11. Agency roles and responsibilities in the Northern Territory.....	39
Table 12. Agency roles and responsibilities in Queensland.....	41
Table 13. Commonwealth agency roles and responsibilities in tropical Australia.....	44
Table 14. Non-government organisations and their roles and responsibilities	49
Table 15. Key planning activities and programs in the study area.....	51
Table 16. Cooperative Research Centres and relevant programs for the study region.....	58
Table 17. Current R&D projects relevant to natural resource planning and management resident in the study area.....	60
Table 18. Research and development priorities for northern Australia identified from research literature	68
Table 19. Summary of natural resource management issues identified by stakeholders in Western Australia.	80
Table 20. Summary of natural resource management issues identified by stakeholders in the Northern Territory	82
Table 21. Summary of natural resource management issues identified by stakeholders in Queensland.....	84
Table 22. Significance of threats to marine resources in potential research regions.....	97
Table 23. Significance of environmental, economic and social issues in potential research regions.....	98
Table 24. Effectiveness of institutional arrangements in potential research regions.....	99
Table 25. Significance of capacity-related issues in potential research regions.....	100
Table 26. Potential for effective research and development in potential research regions.	101
Table 27. Total scores for each stage of the analysis for the selected regions.....	102
Table 28. Potential Strategic Research Objectives for the Kimberley Region – Capacity	107
Table 29. Potential Strategic Research Objectives for the Kimberley Region – Institutions.....	109
Table 30. Potential Strategic Research Objectives in the Kimberley Region – Technical.	110
Table 31. Relationship between R&D proposals and Strategic Research Objectives	115
Table 32. Qualitative assessment of the relative ranking of each of the R&D models.	122
Table 33. Suggested R&D management models for each of the recommended major research proposals	123
Table 34. Budget and time estimates for recommended research proposals.	127
Table 35. Non-resident R&D relevant to integrated resource management in the study region	145

Acronyms and Abbreviations Used

AAD	Aboriginal Affairs Department (WA)
ABS	Australian Bureau of Statistics
AC	Aquaculture Committee
ACMC	Aboriginal Cultural Materials Committee (WA)
ACTEPA	Advisory Council to the Environmental Protection Authority (WA)
ACWM	Advisory Council on Waste Management.
ADC	Aquaculture Development Council (WA)
AEDS	Aboriginal Economic Development Strategy (WA)
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fisheries Zone
ALGA	Australian Local Government Association
ALT	Aboriginal Lands Trust (WA)
ANAO	Australian National Audit Office
ANZECC	Australian and New Zealand Environment and Conservation Council (C'th)
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASIC	Australian Seafood Industry Council
ATSIC	Aboriginal and Torres Strait Islander Commission (C'th)
AUSLIG	Australian Land Information Group
BRS	Bureau of Resource Sciences (now Bureau of Rural Sciences)
CAFNEC	Cairns and Far North Queensland Environment Centre
CALM	Conservation and Land Management (WA)
CER	Community Environmental Review
CHRRUPP	Central Highlands Regional Resource Use Planning Project
CINCRM	Centre for Indigenous Natural and Cultural Resource Management (NT)
CLC	Carpentaria Land Council (QLD)
COAG	Council of Australian Governments
CRC	Cooperative Research Centre
CRCSDTS	Cooperative Research Centre for the Sustainable Development of Tropical Savannas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CYLC	Cape York Land Council (QLD)
CYPLUS	Cape York Peninsula Land Use Strategy (QLD)
CYRAG	Cape York Regional Advisory Group (QLD)
DAFFA	Department of Agriculture Fisheries and Forestry Australia (C'th)
DARTI	Department of Asian Relations Trade and Industry (NT)
DCILGP	Department of Communication, Information, Local Government and Planning (QLD)
DCM	Department of Chief Minister (NT)
DCT	Department of Commerce and Trade (WA)
DEH	Department of Environment and Heritage (QLD – now Environmental Protection Agency)
DEP	Department of Environment Protection (WA)
DEST	Department of Environment, Sport and Territories (C'th)
DLGP	Department of Local Government and Planning (QLD now DCILGP)
DLPE	Department of Lands, Planning and Environment (NT)
DME	Department of Minerals and Energy (WA)
DME	Department of Mines and Energy (NT)
DMR	Department of Main Roads (QLD)
DOGIT	Deed of Grant in Trust
DOLA	Department of Land Administration (WA)
DPIE	Department of Primary Industries and Energy (C'th)
DRD	Department of Resources Development (WA)
DSD	Department of State Development (QLD)
DTRS	Department of Transport and Regional Services (C'th) – now DAFFA

DTSBI	Department of Tourism, Small Business and Industry (QLD – now DSD)
DTW	Department of Transport and Works (NT)
EA	Environment Australia (C'th)
EIA	Environmental Impact Assessment
EKCE	East Kimberley Commission of Elders (WA)
EKRRFAC	East Kimberley Region Recreational Fishing Advisory Committee (WA)
EPA	Environment Protection Authority (WA)
EPP	Environment Protection Policy
ESD	Ecologically Sustainable Development
ERISS	Environmental Research Institute of the Supervising Scientist
FFDG	Farm Forestry Development Group (WA)
FIPC	Fishing Industry Policy Council (C'th)
FPC	Forest Production Council (WA)
FRDC	Fisheries Research Development Corporation (C'th)
FWA	Fisheries Western Australia (WA)
FWPRDC	Forest and Wood Products Research and Development Corporation (C'th)
GBRMPA	Great Barrier Reef Marine Park Authority (C'th)
GLADA	Gulf Local Authorities Development Association (QLD)
GRDP	Gulf Regional Development Plan (QLD)
GRWRS	Gulf Regional Water Resources and Assessment Study (QLD)
GLADA	Gulf Local Authority Development Association (QLD)
HORSCERA	House of Representatives Standing Committee on Environment, Recreation and the Arts
IBRA	Interim Bioregionalisation for Australia
IC	Industry Commission
ICM	Integrated Catchment Management
IDAS	Integrated Development Approval System
ILC	Indigenous Land Corporation (C'th)
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IPA	Indigenous Protected Area
IRDB	Integrated Regional Database
IRM	Integrated Resource Management
KALNRMO	Kowanyama Aboriginal Land and Natural Resource Management Organisation
KDC	Kimberley Development Commission (WA)
KLC	Kimberley Land Council (WA)
KMPS	Kimberley Minerals Prospectivity Study (WA)
KPG	Kimberley Regional Partnership Group (WA)
KWADS	Kununurra-Wyndham Area Development Strategy
KWADSSC	Kununurra-Wyndham Area Development Strategy Steering Committee
LGANT	Local Government Association of the Northern Territory (NT)
LWRRDC	Land and Water Resources Research and Development Corporation (C'th)
MAGOP	Ministerial Advisory Group on Oceans Policy
MCACTZIA	Ministerial Council of Aboriginal and Torres Strait Islander Affairs (C'th)
MCFFA	Ministerial Council on Forestry Fisheries and Aquaculture (C'th)
MLA	Meat and Livestock Australia
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MPC	Ministry for Premier and Cabinet (WA)
MPRA	Marine Parks and Reserves Authority (WA)
MPRSAC	Marine Parks and Reserves Scientific Advisory Committee (WA)

MRC	Meat Research Corporation
MSTPWG	Marine Science and Technology Plan Working Group
MUSP	Multiple Use Strategic Plan (Qld)
NAP	North Australia Program
NASR	North Australia Study Region
NBIS	National Beef Industry Strategy
NFF	National Farmers' Federation
NGO	Non-Government Organisation
NHT	Natural Heritage Trust (C'th)
NLAC	National Landcare Advisory Committee (C'th)
NLC	Northern Land Council (covers northern part of NT)
NORMAC	Northern Prawn Fishery Management Advisory Committee
NPF	Northern Prawn Fishery
NPNCA	National Parks and Nature Conservation Authority (WA)
NRMWG	National Rangelands Management Working Group
NRTEE	National Round Table on the Environment and the Economy (Canada)
NT	Northern Territory
NTCA	Northern Territory Cattlemen's Association (NT)
NTDHLG	Northern Territory Department of Housing and Local Government (NT)
NTMC	Northern Territory Minerals Council (NT)
NTPWC	Northern Territory Parks and Wildlife Commission (NT)
NTTC	Northern Territory Tourist Commission (NT)
NTU	Northern Territory University
NWSEMS	North West Shelf Environment Management Study
OAD	Office of Aboriginal Development (NT)
OAED	Office of Aboriginal Economic Development (WA)
OCS	Offshore Constitutional Settlement
OIC	Ord Irrigation Cooperative (WA)
OND	Office of Northern Development
ONT	Office of National Tourism
ORIA	Ord River Irrigation Area (WA)
OWR	Office of Water Regulation (WA)
PER	Public Environmental Review
PMSEC	Prime Minister's Science and Engineering Council
PWCNT	Parks and Wildlife Commission of the Northern Territory
QCC	Queensland Conservation Council
QCFO	Queensland Commercial Fisherman's Organisation
QFMA	Queensland Fisheries Management Authority
QSI	Queensland Sugar Industry Strategy
R&D	Research and Development
RAC	Resource Assessment Commission
RDC	Regional Development Council (WA)
RDD	Regional Development Division (Department of Commerce and Trade WA)
REDO	Regional Economic Development Organisation
RFAC	Recreational Fishing Advisory Committee (WA)
RIRDC	Rural Industries Research and Development Corporation (C'th)
RPAC	Regional Planning Advisory Committee (QLD)
SCFA	Standing Committee on Fisheries and Aquaculture (multi)
SEAC	State of the Environment Advisory Council
SECWA	State Energy Commission of Western Australia (WA)
SLATS	Statewide Landcover and Trees Strategy
SLCC	Soil and Land Conservation Council (WA)
SMCWS	Southern Metropolitan and Coastal Waters Study

SOMER	State of the Marine Environment Report
SPS	State Planning Strategy (WA)
SRD	Sustainable Rural Development program (WA)
SRDC	Sugar Research and Development Corporation
SWEK	Shire of Wyndham-East Kimberley (WA)
T WA	Transport WA (WA)
U WA	University of Western Australia (WA)
W A	Western Australia
WAFF	Western Australian Farmers Federation (WA)
WAFIC	West Australian Fisheries Industry Council
WAMP	West Australian Ministry for Planning (WA)
WAPC	Western Australian Planning Commission (WA)
WADLG	Western Australian Department of Local Government (WA)
WAMA	Western Australian Municipal Association (WA)
WC	Water Corporation (WA)
WGA	Working Group on Aquaculture
WRC	Water and Rivers Commission (WA)

1 Introduction

1.1 Background and Rationale

Northern Australia is experiencing significant change, with increasing pressure from a variety of land and sea uses in a unique but poorly understood biophysical and socio-economic environment. The pressure to develop is coming mainly from new industries such as irrigated agriculture, tourism and aquaculture. Counterbalancing this pressure is the greater recognition of Aboriginal rights in resource management, requiring research and development agencies to acknowledge and incorporate Indigenous peoples' perspectives, aspirations and science. Conservation goals are also increasingly vigorously pursued.

Tropical Australia has a unique biophysical and socio-economic setting. The coastal and shallow continental shelf habitats of tropical Australia (eg. seagrasses, mangrove forests, fringing coral reefs, offshore coral reefs, megabenthos) are critical for most of the species that sustain Indigenous, recreational and commercial fishing, tourism and aquaculture. They are also critical for several threatened or endangered species (eg. turtles and dugong). The dynamics of these habitats are controlled by the combined effects of terrestrial run-off, climate and oceanography. Of these, only run-off can be significantly affected by human activities: land and water use in the catchments can affect the hydrological cycles that impact on coastal and shallow continental shelf habitats.

Recent assessments of tropical catchments have indicated widespread deterioration in landcover (Roth *et al.*, 1998). Concerns associated with habitat loss, reduced rural economic viability, and an increasing regional dependence on public support have become prominent, have increased public concern for rangelands and a call for restructuring of production systems. Catchments and coastal areas in tropical Australia are also undergoing changes in resource values and uses, ownership, political and economic power structures, as well as in cultural and ethnic diversity. These changes are forcing a shift to new goals, including ecological sustainable development and the preservation of biodiversity; new modes of non-consumptive or low-impact resource use, including recreation and tourism, and new efforts to achieve social justice and self-determination, and preserve cultural traditions.

A meaningful research and information base would help us avoid our previous mistakes of encouraging development without sound knowledge, or even acknowledgment, of the interactions of land use, biophysical, social and economic environments. However, we lack information (including baseline data): we do not understand how systems function and inter-relate at catchment and regional scales; and we do not know what are the roles and functions of resource management institutions and how to achieve 'equity' in resource access and management. Overcoming some of these issues is not, or ever will be, the province of natural-resource research agencies. However, research and development can serve many needs of industry, government and the broader community in some aspects of resource management and use. These needs include the development of effective databases (baseline and monitoring), data use and interrogation tools (decision-support systems, geographic information systems), information synthesis and integration, analysis of resource management and planning institutions and processes.

In May 1998, CSIRO Marine Research and CSIRO Tropical Agriculture were commissioned by the Fisheries Research and Development Corporation and the Land and Water Resources Research and Development Corporation to undertake a six-month scoping study to examine opportunities for the development of strategic research proposal(s) that would aim to support the sustainable development of land, water and marine resources in tropical Australia. This scoping study builds on a workshop held at CSIRO Marine Research, Cleveland, in September 1997, and on two major reports: one to the former Meat Research Corporation (now Meat and Livestock Australia) on the impacts of grazing in northern catchments; and the other to the Fisheries Research and Development Corporation on the research and development needs for marine habitats to sustain fisheries production.

1.2 Aims and Objectives

This six-month scoping study was commissioned to better define and focus appropriate research questions and priorities. The scoping study began in May 1998, and was completed in December 1998. The objectives of the scoping study were to:

1. Identify regional stakeholders and document their key resource management issues and research and development priorities.
2. Undertake data and information review that:
 - develops a meta-database for available regional data.
 - determines information needed to support management.
 - outlines planned development(s).
 - summarises current legislative, jurisdictional and institutional boundaries documenting the scales of management needed.
 - summarises existing planning processes.
 - identifies the key aquatic resources and key catchment areas.
3. Document the activities, skills and resources of research providers.
4. Consider the spatial extent (ie. location and scale) of a potential study(ies).
5. Develop research proposal(s) aimed at supporting the sustainable development of land, water and marine resources in tropical Australia.
6. Consider ways of approaching an integrated multidisciplinary study(ies) and identify potential obstacles and risks to research projects.

1.3 Methodology

The scoping study aims to synthesise social, economic, natural resource and institutional data to develop a systems understanding of natural resource planning and management. It therefore examines biophysical, socio-economic and institutional issues, all of which affect the selection of a study area in which the aims can be achieved. Rather than examining the different resource management systems (eg. fisheries, irrigation), this study focuses on whether an integrated approach would be appropriate and effective.

The geographic focus of the scoping study extends west from Cape York in Queensland to Broome in Western Australia, and includes all catchments flowing into the Gulf of Carpentaria, north into the Timor Sea, Joseph Bonaparte Gulf and Indian Ocean as far south as Broome (Figure 1). As the Cape York Planning and Land Use Study (CYPLUS) covers part of this area, our focus has been from Normanton to Broome, from the Staaten River catchment in Queensland to the Fitzroy River in Western Australia.

The study was undertaken in two parts: face to face interviews with stakeholders; and a desktop review of the literature covering technical issues, management priorities, research and development priorities, and management systems.

1.4 Report Structure

The structure of this report broadly follows the order of the study objectives. Chapter 2 discusses the core aspects of integrated resource management (IRM) in terms of the perspectives it introduces into mainstream resource management. This includes a review of literature on Indigenous resource management in Australia.

Chapter 3 begins with a review of biophysical, social and development issues in tropical Australia. This is followed by an examination of policy and planning issues and, institutional arrangements, natural resource management and existing research and development.

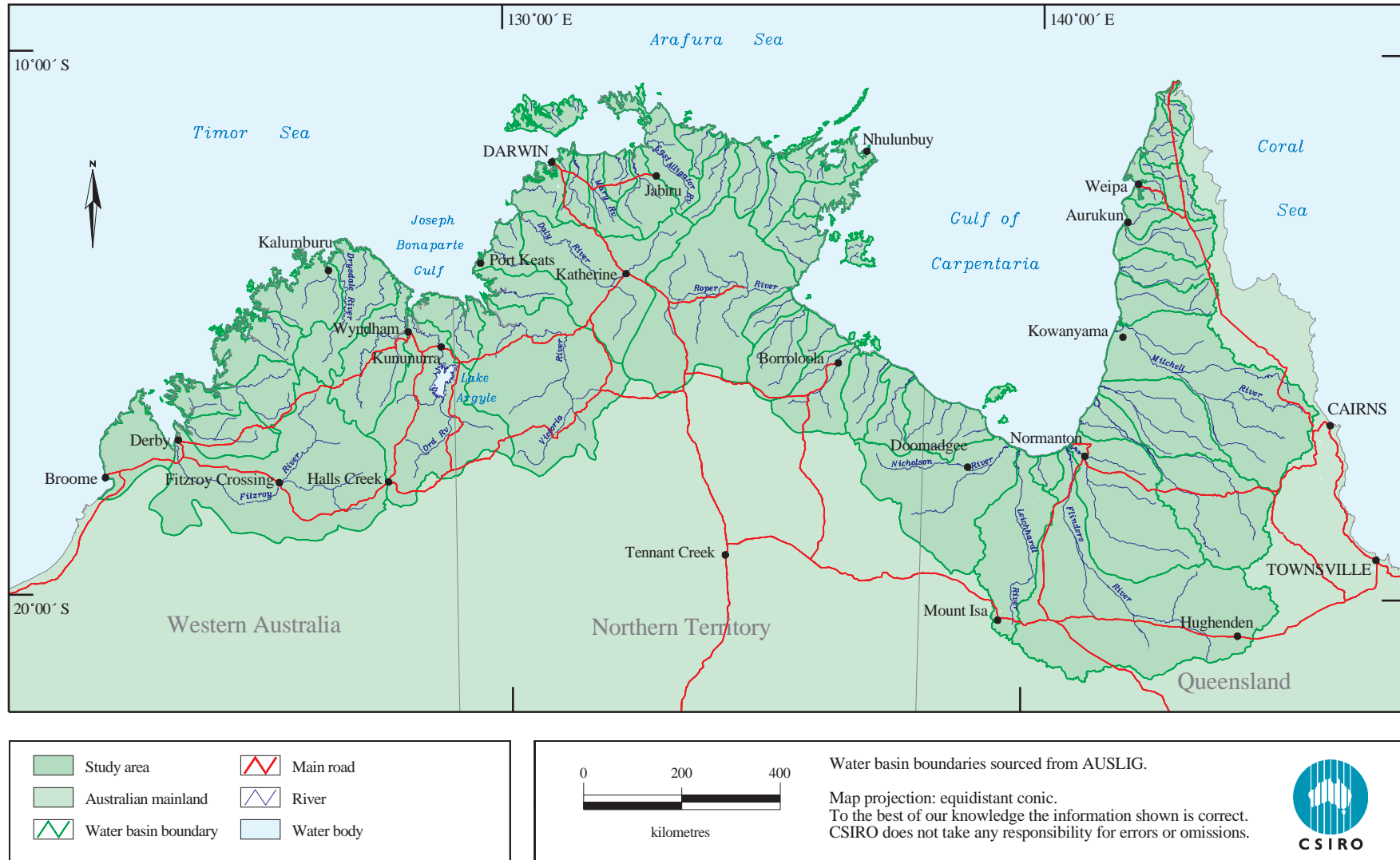
Chapter 4 details key R&D being undertaken in the region and briefly assesses both resident and non-resident R&D capacity. This is followed by an assessment of available natural resource information.

Chapter 5 summarises key findings from stakeholder interviews. They are examined on a State basis, from both a sector and cross-sector perspective, and assessed against the core aspects of integrated resource management. The findings are then used to develop research and development priorities

Chapter 6 integrates material from Chapters 2–5 with a brief review of the Meat and Livestock Australia Scoping Study (Roth *et al.*, 1998). An analysis of impacts on the marine environment is followed by the institutional analysis for the marine sector. All these parts are brought together in a decision matrix to help establishing a geographic and scientific focus for the project.

Chapter 7 considers the issues that research and development could usefully tackle and develops them into strategic research objectives. Chapter 8 presents the conclusions of the report and proposes seven research projects.

Figure 1. Study area boundary.



2 Integrated Resource Management – Key Issues

To support the sustainable use of resources in tropical Australia, planning and management must take an integrated approach (ie. integrated resource management (IRM)). IRM requires mechanisms for multiple-use planning and management of natural resources in both terrestrial and marine environments. Instead of discrete disciplines attempting to manage natural resources, the IRM approach is to draw on all disciplines (or sectors) with an interest in a region to include them in decision-making. Further, IRM objectives are now being developed at different scales (eg. farm, landscape, catchment and region) in an attempt to integrate marine and terrestrial perspectives (eg. Young *et al.*, 1991; RAC, 1993; Finlayson *et al.*, 1997; Hook, 1998; Roth *et al.*, 1998). The integration of planning and management activities is necessarily complex, but it provides an excellent opportunity for research and development. One of the biggest opportunities relates to the practical implementation of IRM (Mitchell, 1997). In this Chapter, we review the key issues in IRM and examine the conceptual context within which future natural resource planning and management in northern Australia will operate.

2.1 Integrated Resource Management

In attempting to implement the goals of ecologically sustainable development (ESD), the Federal and some State governments have encouraged the adoption of integrated resource management principles. The preference for this has arisen for the following reasons:

- Land, water, vegetation and marine resources in many rural areas have become degraded as a result of unrealistic expectations and inappropriate management over time (SEAC, 1996; IC, 1997);
- The Federal Government is a signatory to international treaties that require an integrated approach to natural resource management (eg. Convention on Biological Diversity; the United Nations Framework Convention on Climatic Change);
- The Federal Government is committed to national agreements and strategies that require an integrated management approach (such as the National Strategy for Ecological Sustainable Development [COAG, 1992b]; National Greenhouse Response Strategy [Commonwealth of Australia, 1992]; National Strategy for the Conservation of Australia's Biological Diversity [DEST, 1996]; the National Weeds Strategy [ARMCANZ and ANZECC, 1997], Commonwealth Coastal Policy [EA, 1995], National Oceans Policy [Environment Australia, 1998] and the Intergovernmental Agreement on the Environment [COAG, 1992a];
- Decision-making and responsibilities for natural resource management are often fragmented across a number of public agencies (including three levels of government) and industry bodies, which makes an integrating mechanism essential;
- Both State and Federal governments are tending to devolve responsibilities for environmental stewardship and management to the local level (ANAO, 1997);
- A move to greater diversification in the use of natural resource systems and recognising that stakeholders value these systems for different reasons;
- As an exporter of commodities, Australia faces international markets that are increasingly environmentally conscious; and,
- Communities expect to be involved in making decisions about the environment, and for process to be transparent and the managers accountable.

The challenge of implementing ESD in Australia is compounded by declines in some commodity prices and hence financial ability to implement sustainable management (PMSEC, 1995; ANAO, 1997). Furthermore, demands for economic outputs will continue to affect the management of rural lands and the marine environment in Australia (IC, 1997), although any intensification or expansion of terrestrial or marine industries is likely to exacerbate these effects (Johnson *et al.*, 1997).

Recent reviews/papers on IRM seek to overcome typical management responses and develop improved approaches. These encompass technical, planning, and institutional issues, and capacity development. Each of these is briefly covered below including a brief review of issues for Indigenous resource management.

The emerging paradigm of IRM recognises that natural, political, and social systems, and technology “must work together to resolve wicked problems in the multiple use of natural resources (see Bellamy *et al.*, 1998).

Wicked problems are typically interconnected and complicated, and characterised by uncertainty, ambiguity, conflict and societal constraints (Mason and Mitroff, 1981). To avoid such problems IRM:

- takes an integrated systems approach;
- has a long-term perspective and broad spatial focus;
- regards the whole as being more than the sum of the parts;
- recognises complexity and uncertainty in system interactions;
- recognises the relevance of human and cultural context and diversity in values;
- accepts that people are part of the problem and not outside it;
- focuses on the scale of landscapes, regions or catchments;
- looks to coordinate decision-making amongst stakeholders in government, industry and the community;
- develops strategies for resolving conflict through negotiation; and,
- promotes active community involvement to encourage problem and solution ownership, and ultimately the adoption of sustainable resource use and management practices (Bellamy *et al.*, 1998).

This new IRM paradigm recognises the failures of sector or discipline-based approaches to draw on management and insights from domains outside their own (eg. ecology, policy science and social science). This adaptive approach to ecosystem management and collaborative decision-making has two core principles:

- (i) to maintain and restore the condition or health of the resource; and
- (ii) to reconcile conflicting values, interests and expectations of stakeholders who use and manage the resources, through equitable structures of negotiation and bargaining (Cortner and Moote, 1994; Boehmer-Christiansen, 1994).

Reviews of IRM approaches in different countries recognise several common elements (eg. Lang, 1990; RAC, 1993; Mitchell and Hollick, 1993; Johnson and Bellamy, 1998), namely:

- manage interrelated resources with regard to ecological processes and the maintenance of environmental quality;
- involve multiple objectives and multiple players;
- coordinate government, non-government and community natural resource management policies and activities; and
- involve communities in natural resource management.

The emerging approach to IRM also moves the process of integration beyond coordination to the implementation and monitoring of integrated planning strategies and to decisions on resource management at the catchment or regional level. Hence any attempt to move toward ESD in northern Australia will require not only significant operational innovations, but also a conceptual shift toward adoption of an IRM paradigm.

2.2 Planning Systems

Interest in moves toward integrated methods has been stimulated by recognition of the limitations of rational planning approaches that apply traditional technical and scientific methods, and focus primarily on economic and infrastructure development. These approaches adhere to the planning methodology of survey, analysis and plan, and apply fixed time frames, top-down structures and goal-oriented strategies to planning. They are often the main reason for the failure of planning to have equitable and robust land-use outcomes in multiple-use and multiple-objective contexts (Dale and Bellamy, 1997). Furthermore, they cannot address the types of wicked problems discussed previously (Dorcey, 1986).

However, attempts to promote and implement ESD have proven difficult, often producing inequitable outcomes (eg. Dorcey, 1991; Syme *et al.*, 1994) because:

-
- the problems are complex (eg. RAC, 1993);
 - ESD is a continuous process rather than a particular state for which to aim;
 - policy responses may be flawed;
 - implementation of programs and policies may be ineffective (IC, 1997);
 - strategies adopted to resolve conflict are weak (Dorcey, 1991); and
 - interests without power in the community are frequently excluded (Lang, 1990).

Thus, the shift toward an IRM paradigm has led to a re-evaluation of the function of strategic planning and a search for alternative processes that are more effective at individual, institutional and policy levels (eg. Davis and Weller, 1993; Westley, 1995). These weaknesses can be identified in current regional planning practice in Australia's rangelands. Current regional resource use planning is limited because it has (Dale and Bellamy, 1998; Holmes, 1996b):

- a general focus on non-integrated economic and social development themes or protected area conservation. Consequently regional economic assessment needs greater emphasis on systems analysis and spatial/temporal scale together with improved understanding of environmental, cultural and social links;
- an overemphasis on the spatial representation and data management functions of information technology, with a concomitant lack of interpretative analysis and assistance for negotiation;
- planning remains largely focused on regional structure plans rather than negotiation frameworks;
- institutional arrangements are inflexible and tend to entrench the preparation of structure plans; and
- decision-making power remains centralised.

The findings of Dale and Bellamy (1998) are consistent with those of other planning reviews, particularly planning in Aboriginal communities (Wolfe, 1993), regional planning in north Australia (Holmes, 1994), resource development planning in north Australia (Cowell, 1996), regional planning in the Gulf of Carpentaria (Johnson *et al.*, 1998) and multiple-use management in the Australian marine environment (EA, 1998).

Dale and Bellamy (1998) also suggest that, for IRM to be implemented, there are four key imperatives:

- sound technical support must be available;
- institutional arrangements must be effective;
- the capacity of all stakeholders to participate must be greatly improved; and
- the values and aspirations of Indigenous Australians must be integrated more effectively into planning and management activities.

Responding effectively to these requires broad, context-driven planning able to respond to the unique nature of each resource management problem. We believe that a systems approach is needed for natural resource management to incorporate the principles of ecological sustainable development in tropical Australia. We suggest three elements are central to such an approach:

- technically sound social, economic and environmental assessment to back up negotiations between stakeholders;
- adequate institutional and administrative support; and
- mechanisms for enabling stakeholders to participate in negotiations on the use and management of natural resources.

These elements will influence the direction of future research and development (R&D) in tropical Australia and are used in underpinning the framework for this report. They are discussed in the following sections.

2.2.1 Technically Sound Social, Economic and Environmental Assessment

Natural resource planning and management at the regional scale deals with complex ecological, social and economic interactions in a dynamic situation with long time frames. There is considerable separation between cause and effect, and the potential for irreversible outcomes (eg. Norton *et al.*, 1996). Scientists all too often respond to the complexity by calling for further biophysical research to fill gaps in understanding. Scientists also traditionally seek to develop predictive understanding of systems and process in the belief that this will better inform management decisions. However, such understanding may be practically, or even theoretically, unattainable (Oreskes *et al.*, 1994; Peters, 1991) (which is why ecology and resource management are generally

more speculative than the physical sciences.) As a result, uncertainty and ignorance need to be managed and communicated so that they become valued input to decision-making (Funtowicz and Ravetz, 1990; Costanza *et al.*, 1992; Dovers, 1995).

Clearly, continued biophysical research will be needed to enable more informed and appropriate management of natural resources in northern Australia, particularly in the marine environment. In particular, baseline studies will remain a fundamental requirement. However, it is equally necessary to understand how decisions are made and how science can be integrated into the process. The rational scientific approach is increasingly challenged by the acknowledgment of complexity and indeterminacy and by the apparent irrelevance of much research to decision-making (in terms of impact on practical natural resource management). To effectively integrate scientific understanding into decision-making, researchers now seek to understand the process itself. Only by investing in understanding the context of decision-making and novel facilitation of the uptake of past and future research by decision-makers can scientists hope to have a significant and consistent impact on practice.

Consequently the development of more effective analytical tools and frameworks to both improve understanding of the regional context and “engender adaptive planning and management practices” (Dale and Bellamy, 1998; Walker *et al.*, 1998) is required. Although we argue for an emphasis on understanding institutional and capacity related issues, the role of appropriate technical support for resource management remains paramount. However, the emphasis now needs to shift toward improving our understanding of social, cultural and ecological interactions. The application of information technology in systems analysis also needs to be improved. The technical focus in resource management therefore requires a shift from inventory approaches toward:

- supporting resource-use trade-offs in multiple use/stakeholder environments through environmental, social and economic assessments;
- integrating monitoring and evaluation to feedback into the management process and encourage adaptive processes and institutions;
- developing ways of ensuring competing perspectives have equitable access to information; and,
- emphasising the understanding of ecological, social and cultural processes rather than chemico-physical inventories (ANZECC and ARMCANZ, 1996; Dale and Bellamy, 1998; Walker *et al.*, 1998; Johnson and Bellamy, 1998).

2.2.2 Need for Effective Institutional and Administrative Support

The second key factor in the development of appropriate natural resource planning and management approaches is the establishment of effective institutions (eg. RAC, 1993). For the purpose of this study, institutions are the rules and structures that govern the process of resource management and distribution. They go beyond just the structures of organisations or agencies to include issues relating to resource allocation and rights, monitoring, standards, and stakeholder roles (Fredericksen and Berkoff., 1994; Gunderson *et al.*, 1995).

It is increasingly seen as important that institutions be viewed as an integral part of natural resource management (Lovei and Weiss, 1998; Papadakis, 1996). This emphasis has arisen because of significant changes in their context, such as the greater recognition of Aboriginal resource rights and of ESD as a fundamental tenet (Holmes, 1996a,b). In tropical Australia, the failure of institutions to respond to changing resource use and values has been a major impediment to more effective IRM. The main reason for their failure is that existing institutions were designed for, and evolved in, an era ill-suited to emerging needs (Holmes, 1994; Task Force for the Review of Natural Resource Management and Viability of Agriculture in Western Australia, 1997). The need to focus on institutional issues in resource management also arises because most institutions are established to carry out some set of policies, or mission, and then spend most of their time and energy becoming more efficient in the implementation of these policies, causing strategic analysis to wither. The resulting myopia inevitably leads to a crisis in natural resource management (Gunderson *et al.*, 1995)

The effectiveness of rules and structures in natural resource planning and management depends on the type of resource being managed and the relationship between the users and the resource (Uphoff, 1986). Renewability, seasonality and public perception determine the type of resource and how it is affected by planning and management. Less renewable resources (eg. minerals) arguably require different rules and structures than highly renewable resources (eg. agriculture, fisheries). Where activities are perennial (eg. aquaculture) there is a role for central institutions, which operate in cycles that do not relate to the natural resources being managed (eg. budget, parliament). Where activities are seasonal (eg. fisheries) they are best handled by decentralised

institutions able to respond to fluid resource variation. Public perceptions of rights of access to resources also helps determine which rules and structures are most appropriate.

Three characteristics of users—degrees of interdependence, homogeneity and tradition—also impinge on institutional structure and function. Resource users that depend on each other provide an incentive for good management of the resource. Conflict or competition for resources results in heterogeneous institutional structures, whereas homogeneity makes for uniform management responses. It is, however, critical that institutions incorporate collaborative and consensual approaches as no single rule or structure can overcome the ‘metaproblems’ inherent in ecosystem management (Westley, 1995).

A distinction must also be made between the ‘effectiveness’ of an institution (how well it is achieving its goals), and its ‘efficiency’ (how well it uses available resources to achieve its goals). Institutional understanding also has a distinctly cultural aspect, requiring effectiveness to be seen outside simply technocratic criteria and recognise issues of cultural importance and value (Israel, 1987). Some caution should therefore be used in following recommendations for natural resource management Acts that would supplant existing legislative frameworks or agencies (eg. IC, 1997; Task Force for the Review of Natural Resource Management and Viability of Agriculture in Western Australia, 1997). While there remains significant scope for rationalisation and review, the heterogeneous nature of natural resources and users mitigates against establishing homogenous agency or legislative structures (Walker *et al.*, 1998). A more appropriate mechanism would allow for the design of institutions that review and integrate existing arrangements.

There is some consistency in the literature regarding the core principles for determining the effectiveness of institutional arrangements in resource management. The key themes that emerge are that institutions, be they agencies, policies or processes need to:

1. **Integrate national and local priorities** – institutional arrangements should reflect and respond to changes in national, regional and local resource management goals, particularly in an adaptive management context (Bokhari, 1977; Black, 1995; Lovei and Weiss, 1998);
2. **Allow representation of impacted parties** – institutions require the involvement of various perspectives—community and private sector—and accountability to those perspectives, including equity in distribution of costs and benefits of resource use decision-making. The nature and source of institutional aims and mandate will also impact on effectiveness (Israel, 1987; Born and Rumery, 1989; Gunderson *et al.*, 1995; Dovers and Mobbs, 1997);
3. **Engender political support** – lack of support significantly constrains the ability to enforce arrangements and outcomes, governing the ability of institutions to move from planning to implementation. This includes the extent to which policy is facilitated by legislation and regulations (Born and Rumery, 1989; Black, 1995; Dovers and Mobbs, 1997; Lovei and Weiss, 1998);
4. **Encourage continuity** – arrangements need to have a semblance of continuity in form and function as well as continuity in staff within agencies. However continuity does not equate to inflexibility (Bokhari, 1977; Dovers and Mobbs, 1997);
5. **Be flexible and able to innovate** – innovation and initiative in resource management and the ability to adapt to changing social, economic and ecological circumstance, are essential to effective resource management outcomes (Black, 1995; Gunderson *et al.*, 1995; Dovers and Mobbs, 1997; Lovei and Weiss, 1998);
6. **Incorporate alternative perspectives** – capability and motivation to take into account significant environmental and social externalities which requires consideration of a wide range of alternative solutions beyond isolated sectoral or issue coverage and focus or exclusiveness and inclusiveness (Bokhari, 1977; Israel, 1987; Black, 1995; Dovers and Mobbs, 1997);
7. **Possess appropriate technical capacity** – the technical capacity of institutional systems depends on their ability to generate reliable information on a range of alternative solutions to problems, ensuring that minimum technical standards are met (Black, 1995; Dovers and Mobbs, 1997; Dale and Bellamy, 1998; Lovei and Weiss, 1998);
8. **Be reflective and evaluative** – institutions require the capacity for learning and improvement over time through reflective evaluation of programs and process. Monitoring is also needed to understand and identify remedial responses to changing circumstance and evaluation of impacts (Bokhari, 1977; Black, 1995; Gunderson *et al.*, 1995; Dale and Bellamy, 1998)
9. **Be economically efficient** – able to, for a given set of inputs, achieve effective and proposed outcomes (Bokhari, 1977; Born and Rumery, 1989; Black, 1995); and,
10. **Encourage coordination to avoid unnecessary jurisdictional overlap** – ability to coordinate activities can be constrained by the degree of geographical dispersion of agency activities. Coordination and overlap impact not only on areal jurisdiction among government unit’s spatial scale, but also political and

administrative boundaries. Fragmented functional program responsibilities, ineffective coordination, linkages and relationships with other institutions, including poor mechanisms for, and ease of, cooperation among agencies at all levels all hinder effective resource management (Israel, 1987; Born and Rumery 1989; Dovers and Mobbs, 1997; Lovei and Weiss, 1998).

It logically follows, therefore, that substantial R&D effort is required to review existing arrangements in tropical Australia and to explore alternatives for facilitating negotiation amongst stakeholders over future natural resource use and management.

2.2.3 Mechanisms for Stakeholder Participation

Developing the capacity of stakeholders to participate in integrated resource management is an important component of effective IRM. Capacity development focuses on the need to nurture, enhance and utilise organisational and individual skills and capabilities nationally, regionally and internationally (NRTEE, 1998). Capacity development is therefore the tools and mechanisms to enable effective participation of all stakeholders in achieving desired outcomes from natural resource planning and management processes.

Capacity development emphasises the role of public participation in resource management. Its objective is to improve not only decision-making but also the efficiency of resource management. The (Canadian) National Round Table on the Environment and the Economy (NRTEE) proposed four ways to build capacity (NRTEE, 1998):

1. **Improve the knowledge base for decision-making** – including better data collection, maintenance and analysis, and incorporation of Indigenous knowledge;
2. **Improve policies and strategies** – legislative and policy reform;
3. **Improve management practice and techniques** – including participatory approaches and dispute resolution, and integrated resource management approaches; and,
4. **Institutional reform**: strengthen or create cooperative management arrangements.

Public participation is a critical component of any attempts to develop the capacity of communities and organisations. It can increase the accountability of decision-makers, enlist consensus for implementing decisions, and introduce different perspectives (Hyman and Stiftel, 1988). Effective public participation can also give planning a quality of ‘due process’ (Alexander, 1986) and, by incorporating parochial interests, can help to achieve planning objectives (Reed, 1994).

However, participation is more often seen as a means than an end, as passive participation toward predetermined goals rather than active and dynamic process that may challenge traditional planning modes (Dale and Bellamy, 1998; Oakley, 1991). Therefore, developing, implementing and evaluating natural resource planning and management, as well as increased community control over resources and institutions must become central to participation, if negotiated planning approaches are to be effective and credible. There are significant R&D opportunities to improve public participation in natural resource planning and management.

2.3 Aboriginal Involvement in Resource Management

Despite the demographics of tropical Australia, Aboriginal interests have been largely marginalised in regional economic and resource planning and management (eg. Coombs, 1980; O’Faircheallaigh, 1991; Howitt, 1993; Holmes, 1994; Lane and Dale, 1995). Growing pressure to develop areas of Australia that remain Aboriginal domains can only exacerbate this problem (Ross, 1990a; Connell and Howitt, 1991).

It is important that this perspective is seen in its proper context. While Aboriginal perspectives and interests have not been central to regional planning, Aboriginal people have not been ‘passive actors’ in the resource management landscape. The Kowanyama Aboriginal Land and Natural Resource Management Office (Carr, 1993), Dhimurru Corporation for the Management of Land and Resources, and co-management arrangements in protected areas (Langton, 1998) demonstrate this. However, Indigenous knowledge and knowledge systems have not been incorporated in the rational planning framework, and the planning process adopted by State agencies is largely antithetic to decision processes of Aboriginal communities (Cowell, 1996).

Indigenous natural resource management was reviewed in ‘Caring for Country’ (Young *et al.*, 1991), ‘Still Our Country’ (Johnston, 1996), the CYPLUS Indigenous Management of Land and Sea Project (Cordell, 1995) and other publications. However, their findings were not integrated or implemented effectively. Broader resource management reviews, such as the Draft National Strategy for Rangeland Management (ANZMECC/ARMCANZ, 1996) aimed to create a philosophy of rangeland use and management, and to provide the foundation for planning in the future. The strategy stated that Indigenous peoples have particular rights to the control and management of rangelands and that these rights should be reflected in the laws and administration that govern the use of rangelands. This report identified several key strategies to guide rangeland management namely:

- that rangeland policy and program planning, development and implementation of be achieved through processes negotiated with Indigenous peoples;
- that Indigenous peoples’ rights and interests are recognised and protected; and
- define and document rangelands cultural, heritage and social values to ensure their protection in strategic planning.

Aboriginal communities are frequently, asked to respond to development proposals. Typically, they have done so from a poor resource and information base, and usually when the planning is well advanced. Additional studies, which have often been seen as ‘crisis intervention’ have focused on establishing the primacy of, and raising awareness about, the Aboriginal case (Ross, 1990b). Consultation is frequently inadequate, or unremitting pressure is applied to groups and individuals selected “to sanction development goals” (Altman *et al.*, 1993). The interests of Aboriginal people in land have been defined narrowly, and planning consultation limited accordingly. However, we argue that consultation should not be limited by questions of direct social impact. This is particularly true with the common law recognition of Native Title suggesting a broader consultation and negotiation framework (Niblett, 1993). Typically, to limit the extent of consultation, government has pre-emptively alienated land, excised prospective land from reserves, and excluded Indigenous peoples from pre-planning negotiations. Even when Aborigines can get a seat at the negotiating table, State reserve powers have constrained the ability of Indigenous peoples to “exclude undesired change” (Connell and Howitt, 1991).

Natural resource planning models in Aboriginal communities are generally “premised on a stereotype of Aboriginal communities as geographically bounded and socially cohesive, with democratically elected leadership which legitimately represents the community, and which could, therefore, be used as the focal point for planning” (Wolfe, 1993). In practice, decision-making in Aboriginal communities usually requires that those with rights to speak for the country are consulted and reach a consensus. This process is time-consuming (Chase, 1990). Meetings with external bodies can assist, but are frequently not a suitable forum for internal Aboriginal decision-making and discussion (Ross, 1990a). Von Sturmer suggests that the real question is one of participation in the decisions that create choice (von Sturmer, 1984). This point is emphasised by Dale (1992) in his call for community-based planning models based on optimised community participation, competent technical planning and effective bargaining and negotiation.

Natural resource planning and management should secure cooperative approaches to Aboriginal and non-Aboriginal interests. The fact that Aboriginal interests have not been secured is because planning has failed to involve the participation of Aboriginal interests (Holmes, 1992). Hence any potential R&D responses emanating from this study must recognise both the fundamental role that Aboriginal people play in natural resource planning and management, and develop appropriate structures and mechanisms to facilitate Aboriginal participation in a meaningful and ethical way.

2.4 Summary

In this chapter we have broadly described the theoretical context underpinning integrated approaches to natural resource planning and management. The next chapter also examines the body of available literature and details the regional context underpinning natural resource planning and management on tropical Australia. In so doing we aim in Chapters 2 and 3 to form a useful precursor to synthesis of stakeholder perspectives that follows in Chapter 5.

3 Tropical Australia – Background

Chapter 2 outlined aspects of integrated natural resource planning and management. This chapter describes the region of tropical Australia. It also describes resource management issues identified in existing literature, key institutional arrangements, agency roles and responsibilities, and regional planning programs within the study area.

3.1 Description of Study Region

The area encompassed by this scoping study is shown in Figure 1. It comprises about 25% of the territorial waters and 25% of the landmass of Australia (23% of continental WA, 30% of the NT and 27% of Queensland). The region as a whole has been extensively described (eg. ASTEC, 1993; Reynolds and Lavery, 1997; Finlayson *et al.*, 1997), as have specific areas (eg. KDC, 1997; CYRAG, 1997). This section briefly reviews only selected biophysical, social and economic characteristics of the study area.

3.1.1 Biophysical Regions

Two recent national bioregionalisation projects—the Interim Biogeographical Regions of Australia (IBRA) (Thackway and Cresswell, 1995) and the Interim Marine and Coastal Regionalisation for Australia (IMCRA) (IMCRA 1998)—provide a robust basis for describing the study area (Figure 2). It contains twelve terrestrial and fifteen marine bioregions (Thackway and Cresswell, 1995; Environment Australia, 1998b) (Table 1), which do not necessarily conform with other cultural concepts of land/sea and place (IMCRA Technical Group, 1998). We have used the bioregions as a descriptive tool only. While the IBRA is relatively straightforward, functioning at one scale (regions), the IMCRA has two—provinces and meso-scale regions. As meso-scale regions provide the finest layer of information and are nested within provinces, they were used in this study.

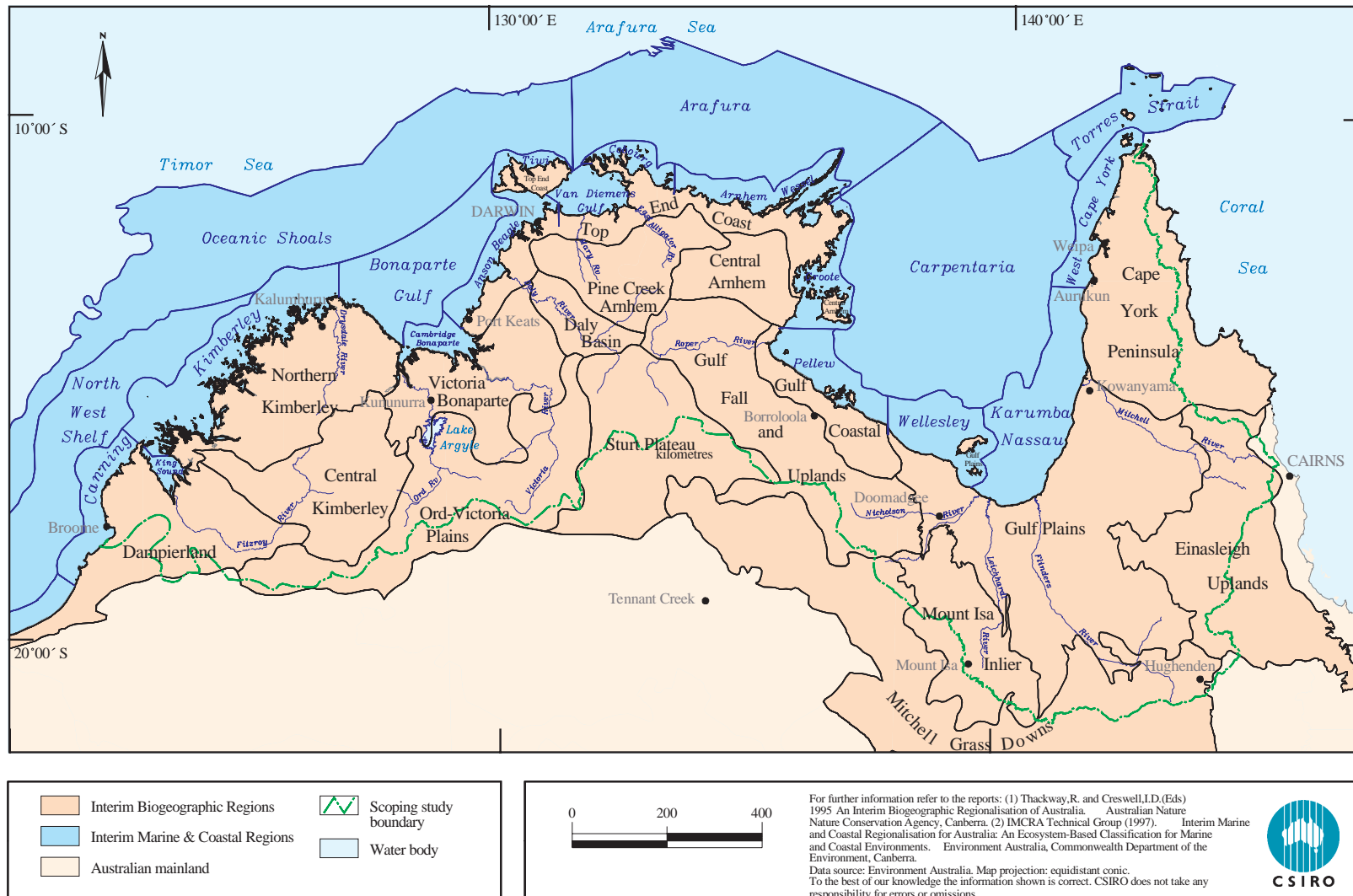
Table 1. Terrestrial and marine bioregions within the study area

State	Bioregion (*Terrestrial, #Marine)	Description
WA	Dampierland*	Sandplains, coastal and alluvial plains and limestone; hot dry tropical climate, vegetation predominantly hummock grass, samphire and scattered woodland.
	Northern Kimberley*	Plateau with savanna woodland and riparian closed forests; mangroves occur in estuaries and closed bays, patches of monsoon rainforest.
	Central Kimberley*	Hilly and mountainous; skeletal soils vegetated with hummock grass and scattered trees.
	North West Shelf [#]	an oceanic region off the Pilbara and Kimberley coasts lying between about the 30 m bathymetric contour and the shelf edge; has diverse benthic invertebrate communities and fish fauna.
	Canning [#]	Northern shore of the Canning Basin; alternating bays and headlands; very large tidal range; little or no river run-off.
	King Sound [#]	Bounded on west and south by Canning Basin, north-east by King Leopold Oregon; overlain by Cainozoic alluvial deposits; mud, sand and gravel flats along the shore, with a narrow mangrove fringe; turbid waters except close to mouth; tidal range is up to 11 m; marine and estuarine flora and fauna have not been studied but appear typical of north-western northern Australia.
	Kimberley [#]	A dissected plateau dominated by Proterozoic sandstones; strong tidal flows and turbid coastal waters; mangroves well developed in land-locked bays; flora and fauna are typical of north west northern Australia.
WA/ NT	Ord–Victoria Plains*	Level or undulating plains with scattered hills, skeletal soils with grasses and scattered trees.
	Victoria–Bonaparte*	Marine sediments with samphire-sporobolus grassland and mangroves; red earth plains; open savanna with tall grasses.
	Oceanic Shoals [#]	Submerged and emergent reefs and cays at the outer edge of the continental shelf, including banks and reef systems closer inshore.
	Bonaparte Gulf [#]	Oceanic currents influenced by Indonesian Throughflow and South Equatorial Current, mainly Permian siltstones; widely scattered patch reefs; although little recorded about marine wildlife, by-catch data indicates fish assemblages are distinctly different from Arafura region to the east.
	Cambridge–Bonaparte [#]	Broad, open marine gulf with five large estuaries separated by stretches of flat shore backed by salt flats.
	Anson Beagle [#]	Exposed, north-west facing coastline; numerous beach-lined coves and bays; prominent headlands; chenier dunes; moderate hills or cliffs without mangroves.

State	Bioregion (*Terrestrial, #Marine)	Description
NT	Top End Coastal*	Arnhem coast; Darwin coast, and Tiwi–Cobourg; mix of soils; undulating with low plateaux, open forest and woodland with sorghum understorey.
	Daly Basin*	Undulating plains with scattered low plateau remnants on Palaeozoic sandstone, siltstone and limestone; loamy and sandy red earths; open forests with perennial and annual grassland understorey.
	Sturt Plateau*	Undulating plains on laterised cretaceous sandstone, neutral sandy red and yellow earths; woodland with spinifex understorey.
	Pine Creek Arnhem*	Rugged hills with skeletal soils; woodland with a sorghum understorey
	Central Arnhem*	Sloping terrain and low hills; cretaceous sandstones and siltstones and laterised tertiary material; yellow sands and shallow stony sands, open forest with grass understorey.
	Tiwi [#]	Numerous deeply indented bays and inlets; extensive areas of mangrove in sheltered inlets and creeks; intermittent fringing reefs.
	Van Diemens Gulf [#]	Drowned river valley systems; low, flat, alluvial, deltaic estuarine floodplains; intermittent smooth, beach ridge shores blended with narrow strips of mangroves; intermittent fringing reefs with well developed mangroves behind.
	Arafura [#]	Generally low relief, mainly submerged strandlines 80–200m depth, Wessel islands in the east; terrigenous sediments only inshore; knowledge of the biology is poor.
	Cobourg [#]	Numerous bays and inlets lined by sandy beaches; minimal sediment input and low turbidity; mangroves only in narrow strips along bays and creek inlets; numerous fringing reefs.
	Arnhem Wessel [#]	Complex coastline of bays, inlets, river mouths and islands.
NT/ QLD	Groote [#]	Rocky shoreline; coastline mainly of large parabolic dune systems; mangroves in narrow strips along creeks and lagoons.
	Pellew [#]	Coastline of alluvial plains composed of clays and muds; mangroves virtually continuous, extending up to 1 km inshore in parts.
	Gulf Fall and Uplands*	Undulating with scattered low hills; skeletal soils and shallow sand; woodland and low woodland with spinifex understorey.
	Gulf Coastal*	Undulating plains with some rugged areas; woodland with spinifex understorey.
QLD	Mitchell Grass Downs*	Undulating downs on shale and limestone; grey and brown cracking clay; grasslands and low woodland.
	Carpentaria [#]	Extensive, fairly shallow (<70 m) offshore region of the Gulf of Carpentaria; mostly muddy substrate except towards the east; high incidence of cyclones.
	Gulf Plains*	Marine and terrestrial deposits of the Carpentaria and Karumba basins; plains plateau and outwash plains with woodland and spinifex.
	Mount Isa Inlier*	Rugged hills and outwash, skeletal soils, low open eucalypt woodland.
	Cape York Peninsula*	Low hills and plains, woodlands
	Einasleigh Uplands*	High plateau of Palaeozoic sediment, granite, basalt, ironbark woodland.
	Wellesley [#]	Coastal and island region encompassing Wellesley Island Group; large coral reefs; inundated by monsoon rains and storm surges in the wet season.
	Karumba Nassau [#]	Inshore-coastal region of low-diversity mangrove forests and extensive salt pans (seasonally inundated); a single tidal cycle; sandy substrates in subtidal areas; large coral assemblages.
QLD	West Cape York [#]	Inshore coastal region; significant freshwater input from coastal wetlands; distinctive mangrove and salt marsh assemblages and fauna.
	Torres Strait [#]	Complex shallow region with extensive shoals, banks and reefs, extensive seagrass beds; biology poorly known except for commercial fish.

Sources: Thackway and Cresswell (1995) and Environment Australia (1998b)

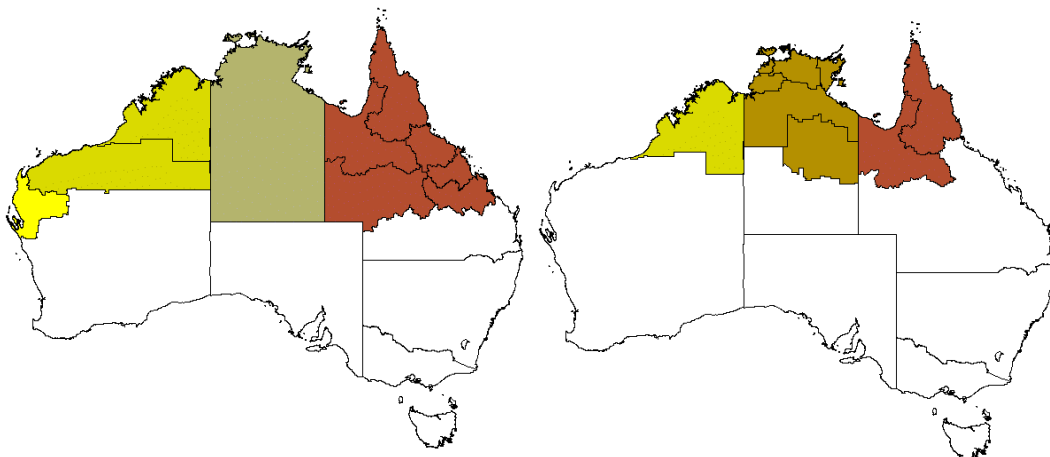
Figure 2. Interim Terrestrial and Marine Biogeographical Regions of Australia and Interim Marine and Coastal Regionalisation for Australia within the study area (Thackway and Cresswell, 1995; Environment Australia, 1998b).



3.1.2 Socio-economic Profile

In 1997 the North Australia Social Research Institute (NASRI) published a comparative social profile of northern and southern Australia (Reynolds and Lavery, 1997). The profile divided north and south based on the 1995 Commonwealth definition of northern Australia according to Figure 3. This study concluded that while regional differences occur, it is possible to talk of north Australia as a social unit distinct from southern Australia (Reynolds and Lavery, 1997).

Figure 3. The map on the left shows the division into north and south Australia used by Reynolds and Lavery (1997); on the right is shown the spatial extent of the scoping study.



3.1.2.1 Population

Using the 1996 population census, broad characteristics of the study region's population are presented in Table 2. The population of northern Australia as a proportion of the Australian population has changed little from 1991 to 1996, at about 6% (1,073,012). Roughly 24% (254,541)¹ of the population of north Australia live in the study area, over half of these are in the nine largest centres, and a third in Darwin.

Table 2. Broad population characteristics of study area in 1996.

Region	Population	Percentage of State	Percentage of Study Area	Including Centres	Population	Percentage of Region
Kimberley	33,028	2	13	Broome	11,368	34
				Derby	3,236	10
				Kununurra	4,884	15
Northern Territory	153,435	60	60	Darwin/ Palmerston	82,484	54
				Katherine	7,979	5
				Tennant Creek	3,856	3
				Nhulunbuy	3,695	2
North Queensland	68,078	2	27	Mt Isa	21,751	32
				Cloncurry	2,459	4
All	254,541			In major centres	141,712	56

Source: ABS Integrated Regional Database 1998 (IRDB 1998)

¹ Population counts are based on the place of enumeration. In Australia 4% of persons are counted outside their statistical local area of usual residence. The population count does not include persons missed by the population census: 1.9% of people were not counted in the census (IRDB 1998).

Indigenous peoples comprise 2% of the total Australian population, but 11% of the north and 23% of the study area's population (although this may be an underestimate (*cf* Martin and Taylor, 1995)). The demographics of major centres such as Darwin also 'skew' these estimates: for example, Indigenous peoples comprise 22% of the study area's population in the Northern Territory when Darwin is included, and 40% when Darwin is excluded (IRDB, 1998).

The population (Table 3) in the study area grew by 21% between 1986 and 1996 (Australia's rate was 15%). However, there was significant variation in the study area (eg. 7% in North Queensland but 32% in the Kimberley). Compared with other parts of northern WA (2% growth) and to WA as a whole (2% growth), growth in the Kimberley region has been very high. With the exception of the Kimberley, the Indigenous population grew faster than the overall population. Some of the growth (eg. Queensland 56% between 1986 and 1996) may be due to more people identifying themselves as Indigenous than in previous censuses, as well as improving census procedures.

Table 3. Population growth in the study region

Region	Population Change (%)			Indigenous Population Change (%)		
	86-91	91-96	86-96	86-91	91-96	86-96
Study Area – Kimberley	18	12	32	13	7	21
Northern Western Australia	2	0	2	12	6	19
Western Australia	13	9	23	11	22	34
Study Area – northern Northern Territory	14	11	27	21	17	41
Northern Territory	14	11	26	15	16	33
Study Area – northern Queensland	6	1	7	9	7	17
Northern Queensland	10	9	20	12	22	37
Queensland	15	13	30	14	36	56
Study Area – northern Australia	12	8	21	16	12	31
Northern Australia	10	8	19	13	17	32
Southern Australia	8	6	14	19	43	70
Australia	8	6	15	17	33	55

Source: ABS Integrated Regional Database 1998 (IRDB 1998)

Population densities in the study area are low, with 25 people per 100 km² (*cf* 400 in southern Australia). Interestingly, it varies markedly within the study area (Table 4): from the Kimberley region at 8 people per 100 km² to the Northern Territory (19 per 100 km²), most probably due to the influence of Darwin. One of the main implications of this for resource-use management is that distributed approaches to regional resource use planning and management will be required.

Table 4. Population density in the study area

Region	Total Population	Area (km ²)	Population Density (persons/km ²)
Kimberley	33,028	419,077.8	0.08
Northern Territory	153,444	803,248.1	0.19
North Queensland	68,080	557,435.7	0.12
Australia	17,889,100	7,730,619	2.31

Source: ABS Integrated Regional Database 1998 (IRDB 1998)

3.1.2.2 Employment

There is considerable variation across the region in terms of industry of employment (Table 5). At the national level, key employment sectors are manufacturing, wholesale and retail trade, and financial/property services.

Collectively, these account for about 46% of the workforce. In the study area, these account for only 26% of the workforce and 21% in the Kimberley. Conversely, government administration, health and education account for 21% at the national level and 31% in the study area. Of the three States, north-west WA has a strong dependency on government administration, health and education (36%), as does the Northern Territory (33%). In north Queensland employment predominantly derives from agriculture, fishing and mining (29%). Since 1986 employment in the north in agriculture, fishing and mining has declined, but has increased in most other sectors. Developments proposed for the region (discussed below) are expected to have a positive impact on these trends.

Employment by sector for Indigenous peoples has a significant influence on these figures. Across the study region, government administration and defence, health and community services and education account for 63% of Indigenous employment, ranging from 52% in Queensland, 64% in the Kimberley (50% health and community services) to 76% in the Northern Territory. However, Aboriginal people are under-represented in the industries central to the northern economy—mining, agriculture, fisheries and tourism: 10% in the Kimberley, 7% in the NT, 16% in Queensland and 12% in the area as a whole.

Table 5. Employment by industry type (percentage figures refer to percentage of total employment for that region).

Sector	Kimberley	Western Australia	NASR Northern Territory	Northern Territory	NASR North Queensland	Queensland	NASR	Australia
Agriculture/ Fishing	1,090 8%	37364 5%	1999 3%	2439 3%	3564 12%	73771 5%	6653 6%	324321 4%
Mining	645 5%	28,486 4%	2,400 4%	2,904 3%	5,111 17%	22,378 2%	8,156 7%	86,156 1%
Manufacturing	423 3%	77,355 10%	3,044 5%	3,612 4%	1,303 4%	149,272 11%	4,770 4%	965,014 13%
Electricity/Gas/ Water	120 1%	6,756 1%	371 1%	533 1%	200 1%	10,158 1%	691 1%	58,685 1%
Construction	737 6%	54,713 7%	5,168 8%	6,148 7%	2,108 7%	102,129 7%	8,013 7%	484,003 6%
Wholesale/ retail trade	1,461 11%	146,758 19%	9,697 15%	12,253 15%	3,863 13%	279,908 20%	15,021 14%	1,483,098 19%
Transport/ Storage	609 5%	30,582 4%	2,934 4%	4,062 5%	1,431 5%	69,594 5%	4,974 5%	332,022 4%
Communication	112 1%	12,630 2%	932 1%	1,285 2%	287 1%	24,042 2%	1,331 1%	150,182 2%
Finance/ Property	898 7%	100,674 13%	6,370 10%	7,973 10%	1,700 6%	174,352 12%	8,968 8%	1,046,595 14%
Government Administration/ Defence	629 5%	31,607 4%	10,460 16%	12,504 15%	2,840 9%	72,008 5%	13,929 13%	372,923 5%
Education	1,022 8%	55,704 7%	4,937 7%	6,175 7%	1,835 6%	102,271 7%	7,794 7%	539,952 7%
Health/ Community Services	3,065 23%	71,467 9%	7,048 11%	9,135 11%	2,430 8%	132,062 9%	12,543 11%	725,102 9%
Recreation/ tourism	1,125 8%	49,050 6%	5,486 8%	7,573 9%	1,968 6%	111,163 8%	8,579 8%	533,990 7%
Personal and Other Services	772 6%	30,242 4%	2,515 4%	3,278 4%	755 2%	51,000 4%	4,042 4%	277,863 4%
Total	13,313	763,207	65,854	82,976	30415	1,420,668	109,582	7,634,739

Source: ABS Integrated Regional Database 1998 (IRDB 1998)

3.1.2.3 Tenure and Resource Use

Terrestrial Resources

Land tenure in the study area is diverse, but mostly it is leasehold, Indigenous tenure or reserved/vacant Crown land (Table 6). It can be concluded from Figure 4, which shows the spatial distribution of land tenure, that any integrated resource management at a regional or catchment scale would have to negotiate a variety of concurrent resource interests and rights. Further recognition of Native Title in resource management requires increasingly adaptive mechanisms for coexistent land use, irrespective of tenure. The current tenure picture was shaped by a substantial transfer of land from privately held leasehold predominantly to National Parks, protected areas and Indigenous tenures. Most transfers have been of marginal lands “incapable of generating adequate income streams to private landowners” (Holmes, 1996b). In the Kimberley, for example, Aborigines control the land that is poorest for pastoral production (Sullivan, 1995).

The most significant recent changes have been the recognition of Aboriginal land rights and the transfer of pastoral land to Aboriginal control, and increasingly, non-transferable titles (such as Native Title or Aboriginal freehold) (Holmes, 1996b). Holmes (1996a) identifies two structural implications of these changes: that commercial pastoralism at the regional level may become subordinated to other use values (as appears to be happening in the Kimberley), and the lack of transferability ensures the land is treated as a non-market good. Although this may be positive in some circumstances, the frequently narrow set of use options it gives rise to, as for some protected areas, is itself a significant constraint for Indigenous peoples.

Although not fully illustrated in Figure 4, Aboriginal people hold a larger variety of tenures than do non-Indigenous peoples. For example, the figures for Indigenous-held land in Table 6, do not include protected areas that are jointly managed (eg. Kakadu). In the Northern Territory, which has a substantial amount of co-managed land, their inclusion means Indigenous peoples have a direct legal right to management of 42% of the Territory. This is not the case in the other States, although Native Title (Figure 5) is causing some change.

Table 6. Land tenure in the study region. Areas are expressed as a percentage of the total land area with percentage of total State/Territory landmass in brackets.

Broad Tenure Type	State			
	WA	NT	QLD	All
Aboriginal-held lease	0.2 (2.3)	0.3 (0.1)	0 (0)	0.2 (1.0)
Aboriginal pastoral lease	10.7 (2.1)	2.4 (1.9)	1.3 (0.3)	3.9 (1.4)
Other Aboriginal land	9.9 (7.9)	31.3 (33.6)	5.5 (1.5)	16.5 (11.5)
Defence	2.1 (0.3)	0.3 (0.1)	0 (0.2)	0.6 (0.2)
Leased land	53.8 (33.7)	54.8 (50.9)	78.4 (46.1)	63.6 (41.9)
Mine reserve	0 (0)	0 (0)	0 (0)	0 (0)
Nature conservation reserve	5.2 (6.7)	7.3 (2.9)	2.7 (19.1)	5.1 (10.2)
Other reserves of public interest	0 (0)	0 (0)	0 (0)	0 (0)
Private land	0 (11.2)	1.1 (0.4)	10.5 (29.1)	4.4 (15.0)
Reserved or vacant crown land	17.9 (35.9)	2.6 (10)	1.6 (3.6)	5.8 (18.8)

Source: AUSLIG National Public and Aboriginal Lands digital data set (1993)

Figure 4. Land tenure in the study area.

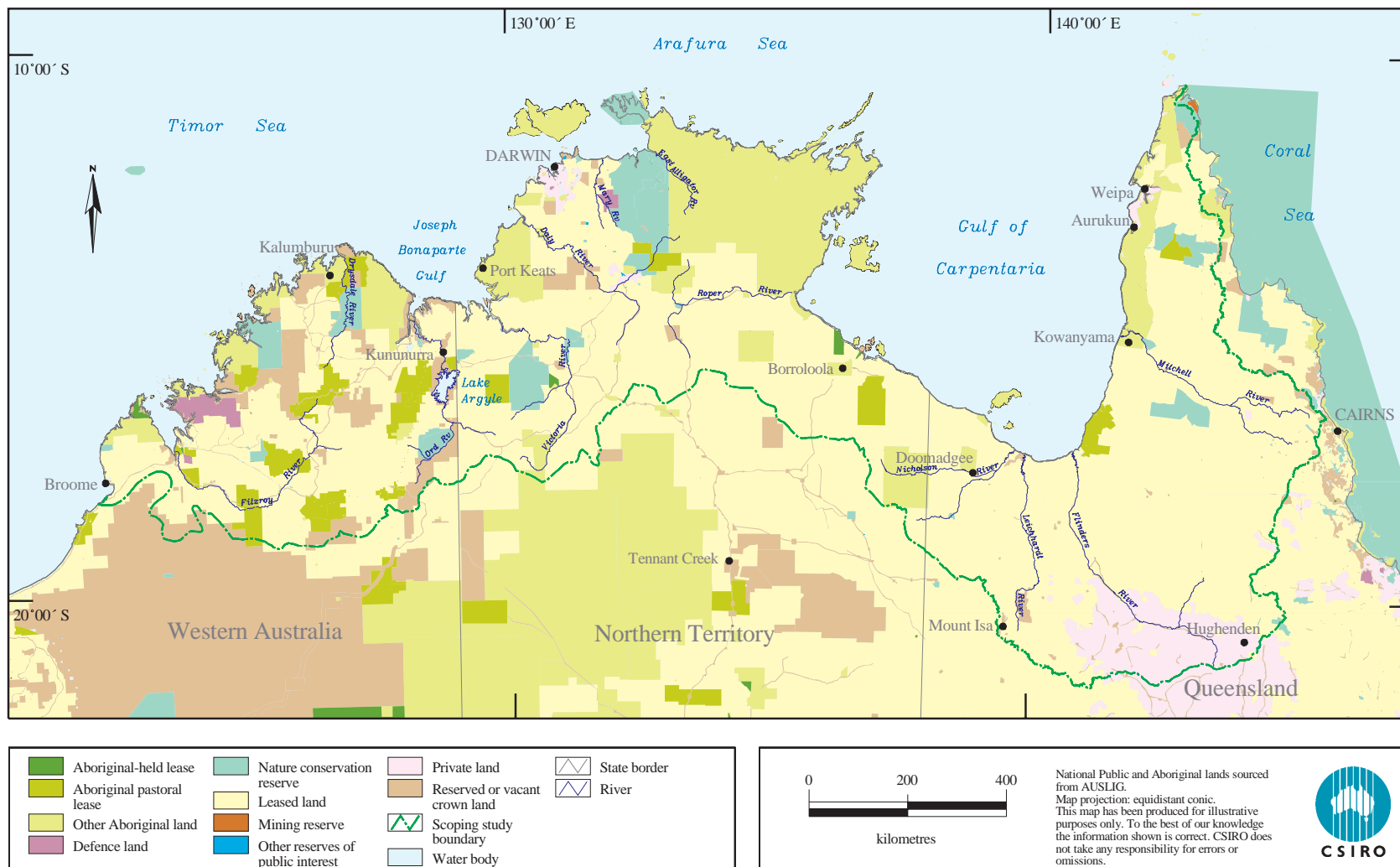
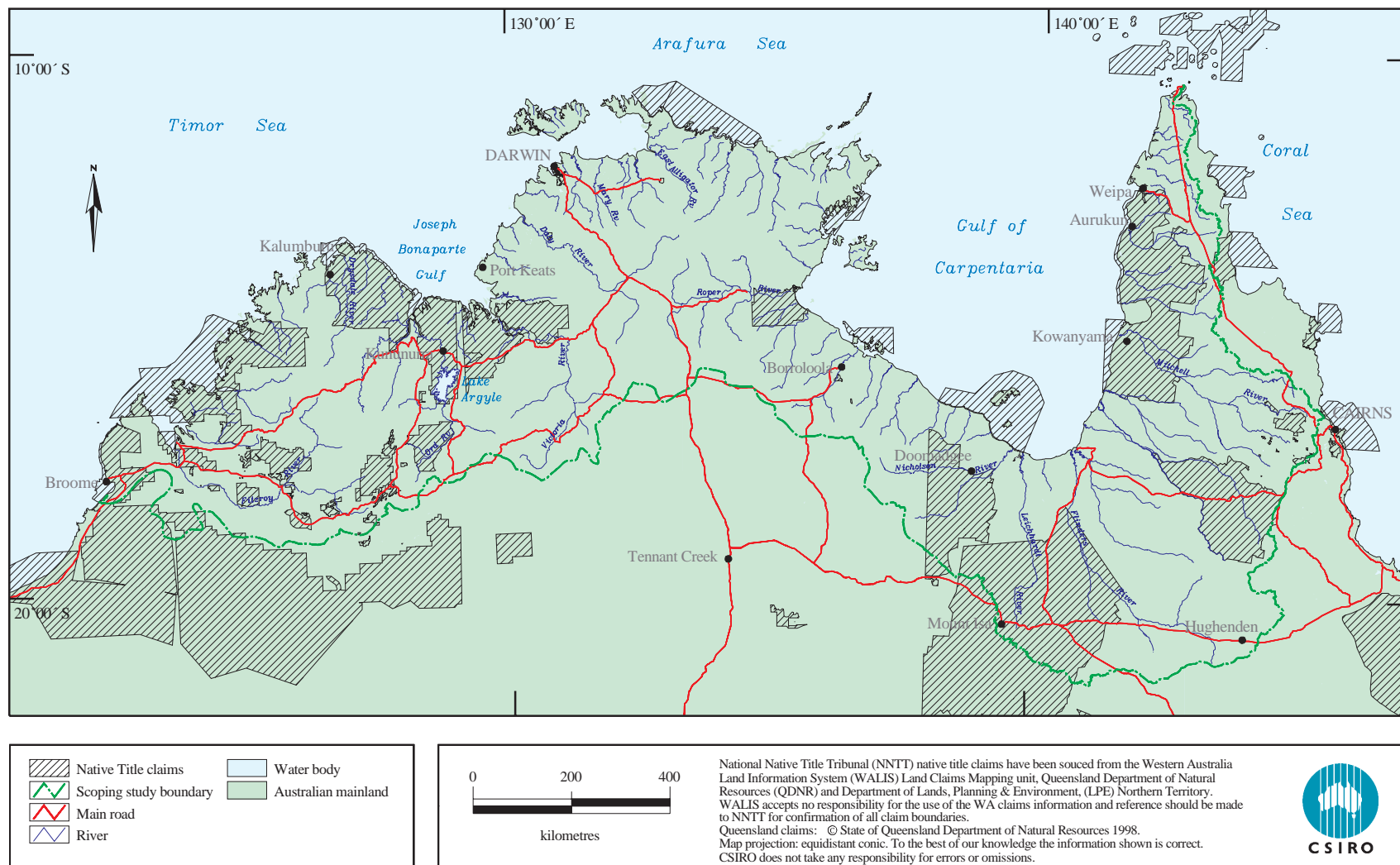


Figure 5. Applications for Native Title determinations in the study area.



Land use for pastoral purposes is the predominant terrestrial resource use activity in the study region in terms of area. While small areas of agriculture exist in the Ord, Katherine–Daly and greater Darwin regions, their economic importance to the region is large. Other activities such as defence and conservation also contribute to the regional economy. Tourism is a major industry in the study region. Tourism has been growing rapidly, particularly in the Northern Territory and Broome areas. The continued growth of terrestrial and marine tourism depends on maintaining good environmental quality. Tourism and recreation are generally thought to be clean and renewable industries. However, they have had significant negative impacts on the environment in some areas including erosion, loss of habitat, declines in flora and fauna and declines in water quality (Dutton and Luckie, 1996). They have also had detrimental effects on social and economic values in some areas (eg. loss of amenity, altered quality of life, increase in traffic congestion and crime). Broome was identified as a location suffering from the unplanned development of tourism. In addition to the above negative impacts in Broome, there has been social conflict between pro and anti-development groups, an increase in the gap between rich and poor, and many Aboriginal people feeling disadvantaged (Dutton and Luckie, 1996).

The combined annual value of production for mining, agriculture (including pastoralism and horticulture) and tourism in the study area in 1995 was approximately \$3.8 billion (Table 7). Mining contributes approximately 75% to the regional economy, agriculture 19% and tourism (accommodation) 6%. The full benefits of tourism encompass more than accommodation revenues, hence this figure represents a significant underestimate.

Table 7. Estimated value of key terrestrial industries in the study region.

Sector	Value per State (\$M) – 1995			
	WA	NT	QLD	Total
Mining	537.8	917.4	1778.2	3269.4
Agriculture	32.1	105.9	274.5	411.6
Tourism	21.9	56.2	78.3	156.4
Total	626.9	1079.5	2631	3837.4

Source: Modified from Kirby *et al.* (1995).

Marine Resources

Marine Protected Areas

One of the core elements of Australia’s Oceans Policy is to identify marine bioregions and establish a representative system of ‘marine protected areas’ (MPAs) to maintain biodiversity, sustain the use of resources, and maintain the integrity of ecosystems in the region (Commonwealth of Australia, 1998). The report on the Interim Marine and Coastal Regionalisation for Australia identified 26 marine bioregions in tropical northern Australia (Thackway and Cresswell, 1998). Additional baseline data are required for all nominated bioregions to support MPAs being established in these bioregions.

MPAs have been defined as “any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment” (Kelleher and Kenchington, 1992; cited by Bleakley *et al.*, 1996). This definition is very broad and MPAs can include habitats and ecosystems in estuaries (eg. tidal lagoons, mudflats, saltmarshes, mangroves), as well as coastal and oceanic waters.

Several different types of MPAs are used in Australia: ‘marine reserves’, ‘marine parks’, ‘marine national parks’, ‘conservation areas’, ‘nature reserves’, ‘coastal parks’, ‘historic shipwreck protected zones’, ‘aquatic reserves’, ‘wildlife sanctuaries’, ‘wetland reserves’, ‘fish habitat reserves’, ‘aquatic life reserves’ and ‘marine national nature reserves’ (Bleakley *et al.*, 1996). In 1992, there were about 300 MPAs in Australia, with about 20 in the study region, covering about 2.6% of the 15,000 km² of the marine waters (includes the Gulf of Carpentaria and North coast bioregions of Bleakley *et al.*, 1996).

- *Western Australia*

In 1996, Western Australia had six marine parks and one marine nature reserve, covering an area of about 1.1 million hectares (Wilson, 1996). The only marine protected area close to the study area is the Rowley Shoals, on the edge of the North West Shelf, west of Broome. However, several areas have been

recommended as additional MPAs in Western Australia, including major marine reserves on the Kimberley coasts to represent tropical mangrove and coral reef environments.

- *Northern Territory*

Because of the isolation and small population of the Northern Territory, there has not been the need for intensive management of marine resources for conservation. In 1996, four MPAs were established under Northern Territory legislation (Billyard and Pyne, 1996) (the Commonwealth is responsible for the marine waters of Kakadu National Park). All Territory MPAs, except for the large Cobourg Marine Park (230,000 ha), north-east of Darwin, are in the Darwin region.

The Northern Territory has started developing a representative system of MPAs, the first of which will be the Beagle Gulf Marine Park in the Darwin region (Billyard and Pyne, 1996). This park will provide for the sustainable use of resources, and protect sensitive and significant sites in the area. Because over 84% of the Northern Territory coast is owned by Aboriginal people, it is critical to involve Aboriginal people in the future planning and management of MPAs in the Territory.

- *Queensland*

Queensland MPAs are classified as 'marine parks', 'fish habitat reserves', 'wetland reserves' or 'fish sanctuaries'. In the study region in 1994, only five fish habitat reserves were declared, with no MPAs in the other categories (Eager and Campbell, 1996). Fish habitat reserves are designed to protect critical habitats that sustain fish and invertebrate populations. They have been declared throughout Queensland to enhance existing and future fishing activities, and protect the habitat upon which fish and other aquatic fauna depend. (Beumer *et al.*, 1997).

Two areas in the Gulf of Carpentaria have high conservation value and are being considered as candidates for MPAs. The Wellesley Islands, north-west of Kurumba, is a region important for its seabirds and dugongs (4,500 in 1994). Western Cape York is likely to be particularly important crocodile habitat, and this has implications for management of the catchments. There are also concerns about the management of whales and dolphins in the Gulf of Carpentaria (C. Kristensen, Queensland Department of Environment and Heritage, *pers. comm.*).

Queensland is currently developing a strategy (for release by the end of 1999) to select representative areas for their possible declaration as MPAs. To support this strategy, several studies have been undertaken in the Gulf of Carpentaria and Torres Strait. These include mapping marine vegetation on both the east and west sides of Cape York and conservation mapping in Torres Strait.

Indigenous Protected Areas

Large expanses of northern Australia are under Aboriginal and Torres Strait Islander control, particularly in the Northern Territory. To develop a comprehensive, adequate and representative reserve system throughout Australia, Indigenous stakeholders are being encouraged to develop 'Indigenous protected areas' (IPAs) on their country. These areas were seen to meet the bioregional planning needs of a national representative system. However, some Indigenous organisations have come to view IPAs in terms of local conservation, social, and cultural benefit in their own right, independently of their representation of a particular ecosystem within a national system of protected areas (Smyth, 1996).

No IPAs have yet been established in the study region. However, studies in the Torres Strait are focusing on identifying potential IPAs in the marine and coastal zone (Dews, 1997). Several IPAs have been established in southern Australia, incorporating both terrestrial and coastal environments. During the life of any large R&D project in northern Australia consideration must be made to the needs of traditional owners of the sea and land and the concept of IPAs.

Commercial Fisheries

There are management plans for 34 species of molluscs, crustaceans and fish in tropical northern Australia, including the identification of factors that have the potential to threaten the sustainable catches of these species (key species are listed in Table 8).

The sustainable production of many of these fisheries is dependent on inshore nursery habitats such as seagrass and mangroves (eg. Loneragan *et al.*, 1998; Vance *et al.*, 1998). The production of these fisheries and the ecosystems that support them are also affected by environmental conditions and river flow (eg. Loneragan and Bunn, in press).

Table 8. Summary of important marine species, their value, fished areas, management plans and gaps in knowledge.

Species	Status	Value \$	Fished Areas	Gaps in Knowledge
Pearl oyster	Fully exploited	\$96.5m (aquaculture)	Sea bed	No studies of stock structure
Endeavour prawn	Fully exploited	\$8m (1991)	Offshore	No studies of stock structure
Tiger prawn	Fully exploited	\$54m (1991–1992) \$33m (QLD)	Offshore	Reasons for decline in landings high research priority
Banana prawn	Fully exploited	\$50m (1992) \$6m (QLD)	Offshore	Resource status of red-legged uncertain
Mud crabs	Heavily exploited	\$8m (NT) \$3m (QLD)	Sheltered estuaries (QLD, NT, WA)	
Tropical sharks	Lightly exploited	\$2.5m (QLD)	Offshore	Status of Whaler Shark population unknown; Low fecundity species vulnerable to overfishing
Barramundi	Stable	\$11–12 kg (1992) \$2.5m (QLD)	Inshore and Freshwater (QLD, NT, WA)	No information on stock structure; Little information known about habitats of juveniles
Coral trout	Stable	\$9–14 kg (1992)	Offshore and Inshore (QLD, NT)	No information on resource status of bar-cheeked trout in WA & NT
Rock cod	Unknown	\$2.50–4 kg (1992)	Offshore and Inshore	No information on stock structure or current status
Sea perch	Unknown	\$3.50–5 kg (1992)	Offshore and Inshore	No studies in stock structure, lack of information on growth & mortality
Tropical snappers	Unknown	\$6–10 kg (1992–1993)	Offshore	No information on stock structure or resource status
Emperors	Unknown	\$6.40 kg (1992)	Offshore and Inshore	No studies on stock structure or resource status
Threadfin salmon	Fully exploited	\$4.50–7 kg (1992)	Inshore and Estuaries	No information on stock structure
Turtles	Vulnerable	Harvested (Green turtles)	Coastal waters (QLD, NT)	Sea life of turtles in general remains unknown & full impact of human disturbances on long-term survival of turtles is also uncertain
Dugong	Vulnerable–Extinction	Indigenous hunting	Seagrass beds & shallow tropical waters (QLD, WA)	General biology still being extensively researched

Sources: Kailola *et al.* (1993); Fisheries Western Australia (1997); DEH (1998); Wetlands Unit of the Environmental Biodiversity Group (1998).

The largest commercial fishery in northern Australia is the Northern Prawn Fishery (NPF), which has a value of about \$110M each year. The NPF covers about 6,000 km of coastline, stretching from Cape York in the east to Cape Londonderry (WA) in the west (Pownall, 1994). It is a multi-species fishery with two major components:

- a daytime fishery for banana prawns (*Penaeus merguensis*, *P. indicus*), mainly in April–May;
- a nighttime fishery for tiger prawns (*P. esculentus*, *P. semisulcatus*), endeavour prawns (*Metapenaeus endeavouri*, *M. ensis*) and some king prawns (*P. latisulcatus*).

The median annual catch for each component is about 4,000 t. The fishery is considered fully exploited (Somers, 1994). About 125 boats, based mainly in Perth, Darwin, Cairns and Brisbane, are licensed to trawl in the NPF. Significant catches of other species are taken during prawn trawling—in the NPF it has been estimated that the annual bycatch from trawling is about 10 times (ie. 80,000 t) the catch of prawns. Bycatch includes species such as shark, squid and scallop that can be sold (byproduct), and others that are thrown back to sea. Steps are being taken to reduce the amount of bycatch in the NPF through the introduction of bycatch reduction devices, starting in 2000.

-
- *Western Australia*
The major fisheries in tropical Western Australia relevant to this study are the northern demersal scalefish fishery, prawn trawling and pearling. The fishery for demersal scalefish is mainly focused on the North West Shelf, with some activity along the Kimberley coast. Most prawn trawling is undertaken in the Joseph Bonaparte Gulf (as part of the Northern Prawn Fishery), with some small operations concentrating around the Broome area and Kimberley coast. Although there is little inshore commercial fishing or charter fishing in the Kimberley or Broome areas, there is potential for expansion in the future.
 - *Northern Territory*
In addition to the prawns caught in Territory waters (valued at \$50 million) as part of the Northern Prawn Fishery, the main commercial species in the Territory are barramundi, mud crab, spanish mackerel, shark, and Timor reef fish (including gold band snapper) (Department of Primary Industry and Fisheries, 1998). Trepang or sea cucumbers are also taken in Territory waters. In 1997–98, the highest mud crab landings on record of 574 t, valued at \$7.7 million, were landed. The total finfish catch for the Territory in this year was 2285 t, valued at \$8 million (at the wharf).
 - *Queensland*
Recent trends in commercial fisheries have been summarised for the whole of Queensland by Williams (1997). The statistics for the Gulf of Carpentaria are not summarised separately and the statistics given below are therefore for the whole of Queensland. Commercial fishing in Queensland is worth over \$400 million each year, employs about 6,000 people and has capital investment of \$250 million. In Queensland, the commercial fisheries are grouped into the following categories: trawl fisheries for prawns, scallops and stout whiting on the east coast (900 boats); net fishery for coastal finfish (150 boats); trap fishery for crabs (180 boats); and a line fishery for reef and pelagic fish (200 boats). Important commercial species caught in the Gulf of Carpentaria are barramundi (total catch for Queensland of 400–500 t), salmon (both blue and threadfin with catches of about 400 t), spanish mackerel (200 t), sharks (600 t) and mudcrab (340 t) (Williams, 1997).

Recreational fisheries

Recreational fishing cannot be viewed in isolation from other fishing activities and knowing the catch and effort by recreational fishers is an integral part of the management of the total fish resource and the environment (Hancock, 1995). The level of recreational fishing is also an important component of tourism, with much of the visitor experience to northern Australia involving participation in fishing from the shore and/or in estuaries. An ABS survey in April 1992 found that 18% of households included people who had undertaken recreational fishing in the previous 12 months. The highest participation rates were in the Northern Territory and Western Australia (McLennan, 1996).

In the Northern Territory, 35% of survey respondents in six population centres had been fishing at least once in the last 12 months (Griffin, 1995). Probably the most sought after fish by recreational anglers across northern Australia is the barramundi (*Lates calcarifer*), which is also fished commercially in Queensland and the Northern Territory. The commercial fishery for barramundi in the Territory has been reduced over the last 20 years to both reverse the decline in stocks, and to provide a greater share of the catch to the recreational fishers. The most popular area for the recreational fishing of barramundi in the Territory has been between the Adelaide River and the East Alligator River. Mud crabs (*Scylla serrata*) are also sought after by recreational fishers across northern Australia and their catch is likely to be significant (Department of Primary Industry and Fisheries, 1998). However, little is known of the recreational take of mud crabs.

In the Northern Territory, over \$30 million was spent on recreational fishing, with visitors spending about \$7 million of this total (Department of Primary Industry and Fisheries, 1998). Nearly \$70 million is invested in recreational fishing boats in the Territory. The Department of Primary Industry and Fisheries is promoting recreational fishing and fishing tourism in the Territory. Clear access to land and resources is essential for this to occur. Recreational fishing is also a major activity in Queensland with an estimated 660,000 people (25% of the population over 18) having fished at least once in the last 12 months in 1996 (Williams, 1997). Recreational fishers in Queensland spend about \$400 million on fishing each year and own about \$450 million worth of fishing equipment and boats. Major centres for recreational fishing in Queensland in the study area are Weipa and Karumba. Recreational fishing can be separated according to fishery accessed by shore, access by privately owned pleasure crafts and access by charter boat (Hundloe, 1985). Thus, access to various areas in northern Australia will determine the issues and impacts from recreational fishing. Recreational fishing effort is increasing around Australia, particularly in the north. A current FRDC project is surveying recreational and Indigenous fishing in Australia (Ann Coleman, Northern Territory Department of Primary Industries and

Fisheries, FRDC project 98/169). The results of this study will help identify issues in recreational fishing, and determine the objectives for research and development in this sector.

Indigenous fisheries

In northern Australia, turtles and dugongs are used by Indigenous peoples (Nicholson and Cane, 1996). The eggs and nesting female turtles were taken from rookeries. Subsistence fishing, hunting and gathering are important current Indigenous uses of the marine environment (Smyth, 1996). Indigenous activities include fishing with spear, net and line; harpooning for dugong and turtle; and collecting shellfish and other shallow water invertebrates. However, in 1996, no comprehensive data were available on the scale of subsistence fishing. Some communities have established databases on the catches of both Indigenous peoples and visitors.

Aboriginal people have little involvement in commercial fishing in the study area (Smyth, 1996). In Western Australia, the One Arm Point and Lombadina communities fish commercially for trochus shell (used to manufacture buttons). In Queensland, the Aurukun community in western Cape York has a small commercial barramundi fishing enterprise. Further south, the Kowanyama people (Mitchell River catchment) have purchased commercial barramundi licenses.

Aboriginal people have a limited but growing interest in aquaculture. In the study area, the Tiwi Land Council (Bathurst and Melville Island) has a 50% share in a pearl farm on the Cobourg Peninsula (Smyth, 1996). There is interest in some areas in the aquaculture of trochus to enhance depleted reefs. In Western Australia, Indigenous communities are increasingly being acknowledged as major users of fish resources, mainly in the north of the State. Fisheries Western Australia is working with Aboriginal groups to develop an Aboriginal fishing strategy for the management and sharing of aquatic resources (Fisheries WA, 1998).

In the Northern Territory, the Department of Primary Industry and Fisheries has a subprogram on Aboriginal Liaison, which focuses on communication and consultation with Aboriginal landholders through six fisheries consultative committees (Department of Primary Industry and Fisheries, 1998). This subprogram was established in 1993 and now includes consultation with the Anindilyakwa Land Council, the Tiwi Land Council and several areas under the umbrella of the Northern Land Council. The committees provide:

- a means for Aboriginal representation to government and fishing industry on resource management;
- a mechanism for cooperation between Aboriginal people, government and industry for the benefit of future use of coastal areas; and
- a forum for discussion of sustainable resource use and the allocation of resources between Indigenous, commercial and recreational uses.

The traditional use of marine and coastal resources by Aboriginal and Torres Strait Islanders is varied and widespread across northern Australia. Despite this, little of Aboriginal maritime culture has been documented (Smyth, 1996). In the north, the pre-colonial maritime culture component of coastal regions was extensive. Traditional Indigenous owners reported extensive sea territories in the Kimberley area, some of which are under claim (Smyth, 1996). The Indigenous peoples of northern Australia use marine resources as part of a holistic cultural relationship—the separation of resource use from management and cultural values is foreign to Indigenous thinking (Cordell, 1992).

Aquaculture

Although production from aquaculture in Australia is small by world standards, the aquaculture industry is very diverse and is expanding rapidly with a 40% increase in tonnage and 80% increase in value between 1992 and 1995 (Preston *et al.*, 1996). Currently, the major aquaculture activity in the study region is the culture of pearl oyster (valued at \$150 million per year; FRDC, 1999). The cultivation of species other than pearl oysters is being explored by the State government agencies in the study area, particularly in Western Australia (Nel, 1997; FRDC, 1999).

The Western Australian Government has ambitious plans for the expansion of freshwater aquaculture in the north and is hoping to reach a target earnings of \$100 million per year in seven years (FRDC, 1999). This government is establishing a tropical aquaculture park in Broome. The species being considered for the rapid expansion of brackish and freshwater aquaculture in the Kimberley include barramundi, sooty grunter and redclaw crayfish. In addition, Lake Argyle catfish are being cultured for human consumption and for conversion to barramundi feed.

Indigenous interests will be an important consideration in the development of aquaculture in the Kimberley region. Recently, the Federal court ruled that the Miriuwung–Gajerrong people hold Native Title over Lake Argyle and 7,000 km² of this region (FRDC, 1999).

The marine species being cultured or considered for aquaculture in northern Australia are: several species of finfish species, eels, prawns, mud crabs, clam, trochus, trepang (sea cucumber), and native aquarium fish (Nel, 1997). The extent of marine culture production in northern Australia may be limited due to unsuitable physical conditions such as distance from the sea, soil types, height above sea level and the local climate. Other factors required for such farming include local infrastructure (power and roads), appropriate technology and connections to suitable local and overseas markets. A recent study looked at potential mariculture sites for prawns in tropical Australia based only on the physical environment in the region. The preliminary results indicate that the eastern side of the Gulf of Carpentaria has the largest potential area suitable for large-scale aquaculture in northern Australia (McLeod, I., CSIRO Marine Research, pers. comm.).

Pearls

A major success of pearl aquaculture in Western Australia has been through the cultivation of the pearl oyster (*Pinctada maxima*). Farms extend from Exmouth Gulf to the Northern Territory boarder. Regional activities of the Fisheries Department of Western Australia include quota and hatchery monitoring, annual inspection of farms and the assessment of pearl farm leases. One issue arising in the pearling industry includes the need for continued access to marine waters that are secure and have suitable environmental conditions. We understand that the pearling industry is negotiating with Indigenous peoples to secure access around Broome area and in the Kimberley.

The total aquaculture production in the Northern Territory was valued at \$58 million (mainly from pearls) in 1997–98 (Department of Primary Industry and Fisheries, 1998). Major investment in aquaculture is being encouraged, and research is evaluating the potential production of mud crabs and gold band snapper.

3.1.3 Resource Development

Proposed resource development in the region is shown in Figure 6 (see DSD (1998), DRD (1998), DARTI (1997), and DPIE (1997) for a full listing and explanation of each project). Significant projects are planned for agriculture (particularly in the Ord, Fitzroy and Katherine–Daly regions), aquaculture and mining.

The offshore potential for discovering major new mineral resources in the study area, except for petroleum, is unknown. In the short to medium term, economic deposits of minerals are likely to be in relatively shallow waters close to the coast. These deposits are likely to include construction materials (eg. sand, gravel, limestone), diamonds, gold, heavy mineral sands and tin (BRS 1995). Deposits of heavy mineral sands are found in nearshore waters but these are not economic. Some onshore deposits of coal, tungsten, manganese and iron ore are known to extend offshore. Other mineral commodities such as phosphate and polymetallic manganese nodules (containing nickel, cobalt and copper) in deep water are likely to be of interest only in the long term (Bureau of Resource Sciences, 1995). Since 1990, applications have been made for 39 mineral exploration licenses in Commonwealth waters. However, not all licenses have been issued (McClennan, 1996).

3.2 Resource Management Issues

This section synthesises the issues of natural resource planning and management in tropical Australia that have been derived from the literature (Table 9). Elicited stakeholder perspectives are provided in Chapter 5.

Figure 6. Proposed resource development in the study area.

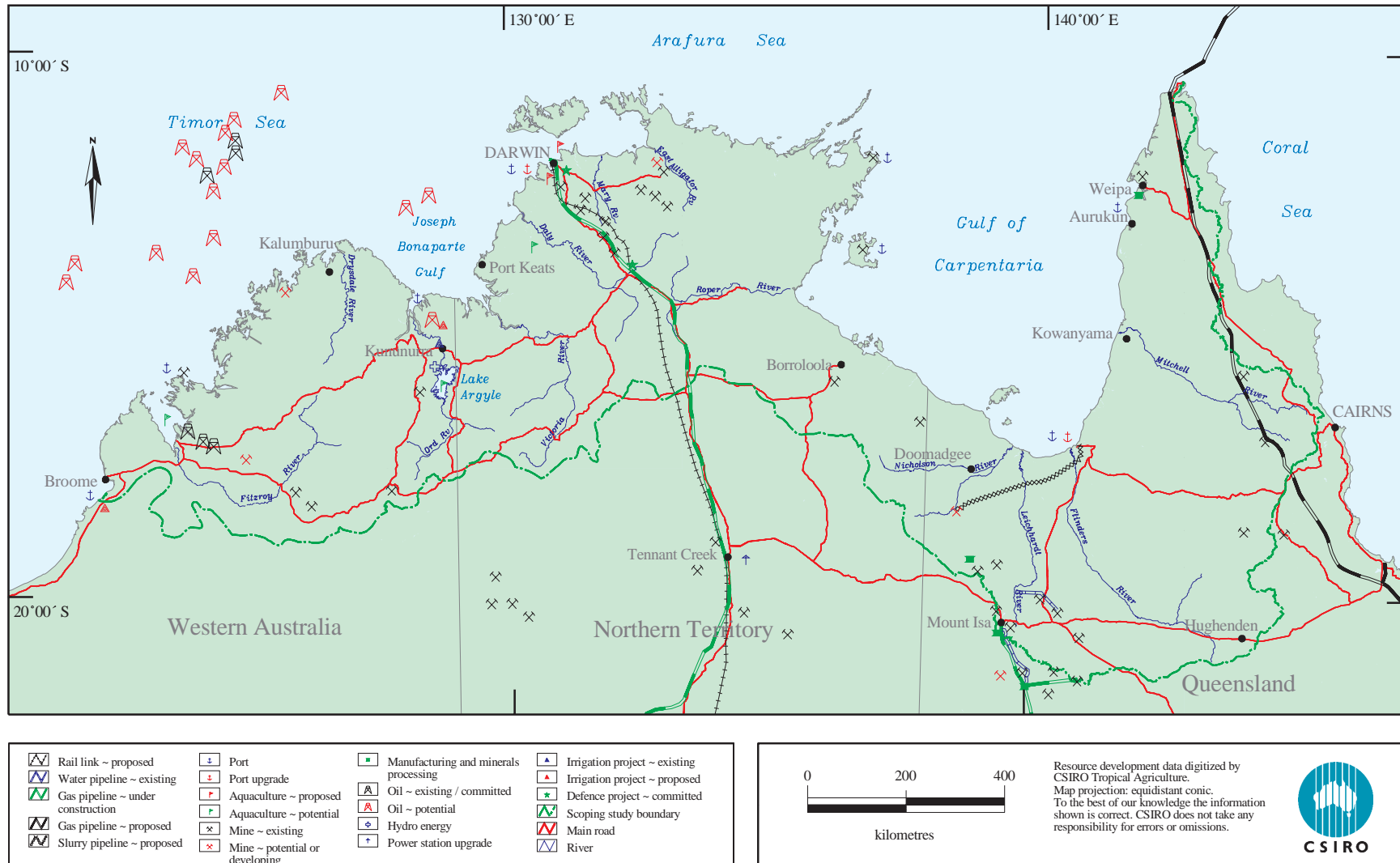


Table 9. Key issues relating to natural resource planning and management in tropical Australia. As identified in published literature.

Issue	Some Possible Causes	Some Potential Impacts	Sources
Declining economic viability of primary production and mining	Declining real prices paid Increasing real costs of inputs/production Unviable enterprise size Slow rate of structural adjustment Limits to operational diversification Inappropriate government policy Exclusion of drought probabilities from farm planning Declining owner/operator equity Declining productivity of primary industry	Need for structural readjustments in some areas for enterprises and businesses Social pathologies Increasing reliance on the public sector Greater reliance on other sources of income Increased resource degradation Increasing farm and business debt	ANAO (1997) ASTEC (1993) Beare <i>et al.</i> (1995) Garside <i>et al.</i> (1997) Hoey (1996) NRMWG (1996) Robertson (1994) Vanclay and Lawrence (1995) Wilcox and Cunningham (1994)
Increasing threats to sustainability of the natural resource base	Over-grazing by domestic stock, feral animals and native herbivores Low productivity of the resource base Land clearance on inappropriate soil and bio-types Decline in native species Significant weed and feral animal problems Fire management and woody regrowth Inappropriate changes in fire pattern Loss of productive capacity of soils Primary industries and mining moving onto marginal lands and environmentally sensitive areas High chemical (fertiliser and pesticide) usage in agricultural production systems Draining acid sulfate soils Inappropriate drainage practices Efficiency in harvesting/processing Use of sloping lands for agriculture/pastoralism in high rainfall areas Clearing of riparian vegetation and of coastal wetlands Emissions, effluent and waste products from processing facilities and urban centres Poor scheduling of water use/irrigation Inefficient use of groundwater resources Unknown impacts of major coastal aquaculture development Construction of ponded pastures and use of introduced grass species Overfishing (recreational and commercial) and incursion of foreign fleets Impact of offshore mining on marine resources Impact of trawl fisheries on environment and bycatch species Fundamental knowledge gaps in both base data and process understanding in relation to marine resources Increasing pressure from tourism	Decline in proportion of desirable perennial pasture species Increase in native or introduced woody species Loss, fragmentation and degradation of habitat Decline in primary production Increase in greenhouse gas emissions Soil structure decline and compaction Declining soil fertility/organic matter Imbalance of soil micro-organisms Increased soil erosion and run-off Loss of terrestrial, aquatic and marine biodiversity Heavy metal contamination and pollution Chemical contamination of primary products and by-products Increased nutrient loads and turbidity of surface and ground waters Increased sediments in estuarine and marine environments Salinisation Acidification of drainage ways and fisheries habitats and fish kills in waterways Inadequate environmental flows Threats to areas of high biodiversity, ecological and recreational significance Significant pressures upon wetland ecosystems Threats to subsistence resource base Possible negative impacts on Indigenous cultural/social systems Destruction of critical coastal and marine habitat Depletion of fish stocks	Arthington <i>et al.</i> (1997) CALM (1994) Crossland <i>et al.</i> (1997) CYRAG (1997) DARTI (1998) DNR (1997) Finlayson <i>et al.</i> (1997) Hoey (1996) Keating <i>et al.</i> (1995) Morton <i>et al.</i> (1995) Novelty (1994) NRMWG (1994; 1996) Rayment and Barry (1993) Robertson (1994) Saalfield (1992) Sattler (1993) Sherrard (1998) Siewort (1998) Tothill and Gillies (1992) Wasson <i>et al.</i> (1994) Wilcox and Cunningham (1994) WRC (1997) Zann (1996)

Issue	Some Possible Causes	Some Potential Impacts	Sources
<p>Poor integration, coordination and implementation of natural resource policy, planning and management</p>	<p>Multitude of (often conflicting) legislation and policy initiatives Fragmentation of responsibilities across and within three levels of government Inequitable taxation of low-income earners and producers Lack of opportunities for community input into decision-making Tourism planning (particularly cultural tourism) not integrated in mainstream planning frameworks Ad hoc decision-making on infrastructure development Lack of clear objectives and strategies for coastal zone management, designation of marine protected areas and marine sector planning Difficulties in integrating management into broader frameworks</p>	<p>Gap between policy intent and outcomes Mixed signals to natural resource managers Mixed or ambiguous signals to primary producers Duplication and inefficiency in community service delivery Poor or ill-informed decision-making on primary industry expansion and related infrastructure development Poor natural resource planning and management.</p>	<p>ATSIC and ONT (1997) Bellamy and Johnson (1997, 1998) Dale and Bellamy (1998) Hoey (1996) Holmes (1996) Johnson <i>et al.</i> (1998) Morton <i>et al.</i> (1995) NRMWG (1994; 1996) RAC (1993) Sattler (1993) Zann (1996)</p>
<p>Conflict over alternative resource uses</p>	<p>Competition between land uses Increasing demand/opportunities for tourism and recreation Short-term planning horizons of State and local governments Poor natural resource allocation processes Inadequate system of reserves and conservation zones Lack of integration of Indigenous aspirations into planning and management of terrestrial and marine resources Social 'sector' largely unrepresented in regional land use planning and zoning Planning, development and implementation of policies and programs not achieved through processes negotiated with Indigenous peoples Lack of knowledge of traditional owner usage/valuation of coastal and marine resources</p>	<p>Social tensions between community interests Uncertainty for all stakeholders Unsustainable development on marginal or ecologically sensitive lands Demand for industry structural readjustment Marginalisation of Indigenous peoples in natural resource development Social conflict and dislocation Unnecessary litigation Rights and interests of Indigenous peoples not recognised and protected</p>	<p>ANZECC/ARMCANZ (1996) ASTEC (1993) Cordell (1995) Dale and Bellamy (1998) Finlayson <i>et al.</i> (1997) Holmes (1996a,b) Johnston (1996) Langton (1998) Morton and Price (1994) O'Faircheallaigh (1991) Robertson (1994) Sattler (1993) Young <i>et al.</i> (1991)</p>
<p>Social problems in rural and regional communities</p>	<p>Economic decline of family business enterprises Isolation and lack of communication Declining terms of trade Declining employment opportunities Lack of training causing social problems and welfare dependency Declining rural population Downsizing of social infrastructure in rural communities Personal stress Changing community values Declining government capacity to deliver services Inadequate reflection of Aboriginal values in land and marine management and planning Poor development and implementation of appropriate community planning and consultation methods</p>	<p>Declining productivity Threat to viability of social structures Worsening indicators of social dysfunction Declining productivity Aging primary producer population Threat to viability of social structures Marginalisation of Indigenous peoples in natural resource development</p>	<p>ASTEC (1993) Bellamy and Johnson (1997) Coombs (1980) Dale and Bellamy (1998) Finlayson <i>et al.</i> (1997) Hoey (1996) Holmes (1996a,b) Johnson <i>et al.</i> (1998) Langton (1998) Morton <i>et al.</i> (1995) NRMWG (1996) O'Faircheallaigh (1991) DLGP (1998) Vanclay and Lawrence (1995)</p>

3.3 Institutional Arrangements

As discussed in Chapter 2, institutional arrangements can be either an impediment or precursor to the establishment of effective natural resource planning and management. Institutional arrangements impacting on natural resource planning and management in tropical Australia are described in Tables 11–14. We describe four institutional arrangements that currently affect tropical natural resource planning and management: State agencies and their legislated responsibilities, local government, non-government organisations, and planning processes and programs. A fifth institutional arrangement, land tenure, has already been discussed.

In addition to the core institutional arrangements discussed in this report, there is a range of other programs and activities related to natural resource management in the study region. These include, for example, Landcare, Coastcare, Ribbons of Blue and Water Watch. Indeed, some, such as Landcare, have left an “indelible mark on the social landscape of Australia” (Lockie and Vanclay, 1997) and epitomise community action in sustainable resource management practice. In Queensland the role of Landcare has recently been institutionalised through legislation incorporating Landcare principles. However, while these activities are important in their own right, we do not discuss them in this report as their presence or absence is unlikely to adversely impact on any potential R&D investment. Their importance at the local level, and in any work beyond this scope, is unquestioned.

3.3.1 State Agencies and Their Legislated Responsibilities

For the purposes of this discussion we have placed each agency into a ‘sector’. Indigenous resource management agencies have a much broader resource-management charter than do non-Indigenous agencies, encompassing marine, terrestrial and social justice aspects of management, with added cultural issues and responsibilities. These organisations are typically either ‘grouped’ together, thereby removing Indigenous perspectives from ‘mainstream’ discussion, or there is a lone Indigenous perspective presented among a large body of other, frequently antagonistic, perspectives (*cf* Sullivan, 1995). We have placed them as separate entities within the relevant jurisdiction.

We first present for each State and the Commonwealth, a brief summary of what we believe are the key pieces of legislation in the study region in each jurisdiction in the areas of environment protection and conservation, mineral development and regulation, impact assessment and planning and resource development. The aim of this summary is to provide an overview of the resource management legislation in each jurisdiction.

3.3.1.1 Queensland

- *Environmental Protection Act 1994*

This Act is the principal Act governing environmental protection in Queensland and is administered by the Department of Environment and Heritage. The Act applies to the activities of public and private entities alike. It has the following key functions:

- licensing ‘environmentally relevant activities’;
- auditing license holders for compliance;
- evaluating land for contamination and issuing orders for remediation of contaminated land;
- issuing environmental protection orders;
- preparing environment protection policies (EPPs);
- prosecuting proponents of unlicensed discharges and other activities which contravene the Act; and
- administering a business incentive scheme to foster environmental compliance.

Environmentally relevant activities are defined as those releasing a contaminant into the environment. The Act focuses on pollution, affecting development requiring waste management.

- *Nature Conservation Act 1992*

The *Nature Conservation Act* is also administered by the Department of Environment and Heritage. The following are the Act's key functions.

- The Act legislates for the declaration and classification protected areas including national parks, conservation parks and national parks (Aboriginal land).
- It legislates for conservation agreements over privately owned land.
- Management plans and conservation plans are required plans for protected areas.
- All cultural and natural resources of protected areas are the property of the State.
- Removal of cultural and natural resources of protected areas is restricted.
- The Act legislates for the classification and protection of rare and threatened wildlife (both animals and plants), including international migratory species.
- The collection, removal, breeding and release of wildlife requires a license or permit.
- The Minister for Environment may issue 'interim conservation orders' to halt any activity believed to be causing harm to wildlife or its habitat, even if the wildlife or its habitat is outside a protected area.
- The Act allows for compensation to be paid to people affected by interim conservation orders.

The *Nature Conservation Act* (s.93) legislates conditions and circumstances where Indigenous Australians may lawfully take and use wildlife "under Aboriginal tradition or Island custom". However, at the time of printing, this section had not been proclaimed.

- *Coastal Protection and Management Act 1995*

This Act aims to provide a coordinated and integrated management and administrative framework for the ecologically sustainable development of the coastal zone (s.3(c)). It specifies that this will be achieved through coordinated and integrated planning and decision-making, involving coastal management plans (s.4). The Act also legislates for regulatory powers and penalties for non-compliance. The Act defines coastal management as "...the protection, conservation, rehabilitation, management and ecologically sustainable development of the coastal zone." This Act has the potential to affect diverse activities in the Coastal Zone.

The Act:

- Specifies its application to the management of activities on land which affect coastal waters.
- Acknowledges that Indigenous peoples are particularly concerned with coastal land if they live on or near this land or have a particular connection with this land under Aboriginal tradition or Island custom (s.13).
- Establishes the Coastal Protection Advisory Council to advise the Minister responsible for the Act on all matters relating to the management of the coastal zone.
- Specifies that the Minister must prepare and implement a State coastal management plan for the coastal zone and regional coastal management plans for defined portions of the coastal zone.
- Specifies that planning schemes may be amended to comply with coastal plans.
- Allows the Minister to declare certain areas 'control districts' where areas require special management.
- Legislates for coastal protection notices and tidal works notices which have the capacity to stop, prevent from starting, regulate and require specified activities in the coastal zone.
- Legislates for declaring a 'coastal building line' which prevents construction seaward of that line (s.59).
- Legislates for investigation and enforcement officers with powers of entry, investigation and to issue notices in accordance with the Act.

- *Integrated Planning Act 1997 (IPA)*

The IPA aims to incorporate greater public input into planning schemes. The Act introduced the Integrated Development Approval System (IDAS) which has been designed to apply to coastal development,

environmental licenses and heritage approval. The IPA has been developed to recognise Landcare and ICM groups as Regional Planning Advisory forums, and to consider their recommendations in regional plans. The Act states that its purpose is to achieve ecological sustainability by (s.1(2)):

- coordinating and integrating planning at the local, regional and State levels;
- managing the process by which development occurs; and
- managing the effects of development on the environment.

The Act comprises many functions in a single piece of legislation, including the coordination of land-use planning and decision-making processes, the management of land and building development, legal and appeal processes for disputes over land use and development (Moon, 1998:24). The key functions of the Act include:

- defining concepts in integrated planning.
- legislating for local councils and the Minister for Planning to be satisfied that local and regional planning schemes are consistent with these concepts of integrated planning .
- legislating for ‘planning scheme policies’ to be made by local governments to support their planning schemes .
- defining procedures for revising planning schemes.
- legislates for the Minister for Planning to direct a local government to review its planning scheme.
- describing the procedures for making and amending State Planning Policies (Schedule 4).
- enact the Integrated Development Assessment System (IDAS) to guide the assessment and approval process for new developments.

- *State Development and Public Works Act*

The *State Development and Public Works Organisations Act 1971* (s.29) requires government bodies (departments, authorities, corporations and local government) to have regard for the environmental impact of proposals being considered. Where a development might impact significantly on existing infrastructure or the Queensland economy, the government can insist on an EIA under the *State Development and Public Works Organisations Act 1971*, covering all aspects of a development proposal. Doing so allows rapid expedition of specific projects.

3.3.1.2 Western Australia

- *The Conservation and Land Management Act 1984*

This Act establishes the WA Department of Conservation and Land Management (CALM). The Act also legislates for three peak bodies in which natural resources are vested. These bodies influence the activities of the Department through advisory committees established by the Act. State forests and timber reserves are vested in the Lands and Forests Commission (LFC); national parks, nature reserves and conservation parks are vested in the National Parks and Nature Conservation Authority (NPNCA); and marine reserves and marine parks are vested in the Marine Parks and Reserves Authority (MPRA). The CALM Act establishes the permit and licensing system for access to and use of natural resources vested in the peak bodies, and requires the peak bodies to produce plans of management for the resources and protected areas they manage.

- *Environmental Protection Act 1986*

This Act establishes the environmental impact assessment (EIA) framework for Western Australia. The Act legislates for the Environmental Protection Authority (EPA) to administer EIA and to provide independent advice to the Minister. Three forms of environmental review are created by the Act: a Consultative Environmental Review (CER) is reserved for easily managed impacts and when public interest is limited to local community groups; a Public Environmental Review (PER) requires detailed description of environmental factors and is used for proposals of major public interest; an Environmental Review and Management Program (ERMP) is WA’s most comprehensive and detailed level of assessment used for major projects which have State-wide interest. The Act also gives the EPA the power to conduct its own investigations when unsatisfied with environmental reviews. In addition to EIA, the Act requires the EPA to conduct state of the environment reporting and to prepare environmental protection policies.

-
- *The Mining Act 1978*

This Act defines the approval procedures for mining proposals in different classifications of private and Crown land. The Act legislates for the license and permit arrangements that regulate prospecting and mining operations.

- *Water and Rivers Commission Act 1995*

This Act establishes the Water and Rivers Commission (WRC) as the principal management and research organisation for water resources in WA. The Act legislates for the WRC to grant bore licenses to properties under a separate arrangement from the management of mains water.

- *Western Australian Planning Commission Act 1985*

This Act creates the Western Australian Planning Commission (WAPC) and defines its key tasks as preparing and implementing a State Planning Strategy (SPS), monitoring and forecasting land supply throughout the State, and conducting research on contemporary trends in planning. The SPS is described as State-wide regional planning, and is a guide for decision-making according to the individual characteristics of each region in the State. The *Western Australian Planning Commission Act* also allows regional planning committees such as the Kimberley Region Planning Committee which is preparing the Kununurra Wyndham Area Development Strategy (KWADS).

3.3.1.3 Northern Territory

- *Parks and Wildlife Commission Act 1995* and the *Territory Parks and Wildlife Conservation Act 1978*

The first of these created the Parks and Wildlife Commission of the Northern Territory (PWCNT) as the body responsible for the management of the protected areas established under the Act, and for the regulation of the use of wildlife. The second Act legislates for the declaration and management of protected areas, provides for conservation agreements for private land and declares a classification and protection scheme for threatened species. This Act regulates trading of native animals and gives officers powers to control pest species. The Act also legislates for the potential to manage protected areas in conjunction with Aboriginal Land Councils.

- *Mining Act 1980*

This Act defines the different types of permits, licenses and leases required for mineral exploration and extraction. The Act legislates for certain conditions that apply to protected areas declared under Territory and Federal legislation. Mining tenements in Commonwealth national parks require consent from the Commonwealth Minister responsible for those parks. In the case of an application for a mining lease within a protected area declared under Territory legislation, the Territory Minister for Mining needs to be satisfied that the lease is consistent with the management plan for that park, and if the protected area is declared under the *Territory Parks and Wildlife Conservation Act 1978* then the written approval of the Minister responsible for this Act is also required. The Act also legislates for compensation for damages caused by mining.

- *Environmental Assessment Act 1982*

This Act legislates for EIA procedures in the Northern Territory. It authorises the Minister or administrator responsible for the Act to request a public environmental report or an environmental impact statement, or any other information the Minister requires to assess the likely impacts of a proposed development. The Act allows, but does not require, the making available of public environmental reviews and environmental impact statements for public comment. The Minister has the power to exempt proposals from the Act (s.7.2(h)). The Act does not legislate for environment protection policies or state of the environment reporting. The Act does not create any agencies or scientific committees to administer the Act or advise the Minister.

-
- *Planning Act 1993*

This Act has the objective of providing appropriate and orderly planning and control of the use and development of land. The Act creates the Northern Territory Planning Authority as the agency administering the Act, and defines the powers of this agency. The agency or Minister may declare or amend a land use objective in relation to an area, and may prepare a land use control plan for that area. The Act gives the Minister the ability to call for submissions on a land use control plan and must make it available for public viewing for a period of one month. The Act defines the application and approval process for developments, and establishes the penalties for failure to comply with land use planning schemes.

3.3.1.4 Commonwealth Legislation

- *Native Title Act 1993 and the Native Title Amendment Act 1998*

These Acts represent, together with their broader social and political implications, a significant institutional change in land management policy. The two Acts, in providing for the recognition of Native Title directly influence and impact on the management of land, water, flora and fauna. The *Native Title Act 1993* (C'th) sets out rules that must be observed for the valid regulation of Native Title rights. The existence (or potential existence) of Native Title rights and interest is therefore an important consideration in resource management. There have been significant questions about the recognition of Native Title over offshore areas, and while the recent Croker Island Case recognised Native Title in the offshore zone there are still aspects of that decision to be clarified. The recent decision in the Kimberley region has further redefined these issues toward a greater integration of Native Title rights in broader resource management regimes.

The procedural rights of Native Title holders vary greatly amongst the different provisions of the Act, but in essence Native Title holders are entitled to the same procedural rights as an owner of freehold for an onshore place that is land. For example, in relation to protected areas, the amended *Native Title Act 1993* (C'th) allows the use of existing 'reserves' validly established before 23 December 1996 for the purpose for which it was reserved. However, new protected areas cannot be established on Native Title land before Native Title has been compulsorily acquired or, in some cases, until Native Title holders have given their consent. Protected areas can also be established where there is an Indigenous land use agreement.

The key provisions of the Acts relating to land use planning, are those dealing with 'future acts', the special right to negotiate, and Indigenous land use agreements.

- *Natural Heritage Trust of Australia Act 1997*

This Act creates the Natural Heritage Trust (NHT) from the partial privatisation of Telstra and appropriation of Government revenue. The Act specifies five principal programs funded by the NHT: the National Vegetation Initiative (Bushcare), the Coasts and Clean Seas Initiative 'Coastcare', the Murray–Darling 2001 Project, the National Land and Water Resources Audit and the National Reserve System (NRS) (s.8). The Act defines which other programs are eligible for funding, including programs which support environmental protection, sustainable agriculture and natural resource management. The Act is jointly administered by Environment Australia and Agriculture, Fisheries and Forestry - Australia. The NHT Board is created by the Act.

- *Biodiversity Conservation Bill 1998*

This Bill proposes to replace all existing Commonwealth conservation and environmental management legislation with a single, integrated piece of legislation. It proposes more defined roles for the Commonwealth and States and emphasises bilateral agreements. The Bill gives greater autonomy to the States in its proposed framework for conservation agreements, management of nationally and internationally significant protected areas, conservation plans and protection of endangered species. The Bill emphasises a monitoring role for the Commonwealth.

- *Environment Protection Bill 1998*

This Bill proposes to replace the *Environment Protection (Impact of Proposals) Act 1974*. The Bill removes some triggers to EIA at a Commonwealth level, with the effect of increasing the autonomy of State EIA. The proposed piece of legislation would only apply according to a “tightly defined test of national environmental significance”.

- *Environment Protection (Impact of Proposals) Act 1974*

This Act was the first piece of legislation to establish environmental impact assessment (EIA) arrangements in the Commonwealth sphere of government. The Act requires the decision-making process of Commonwealth departments and agencies to include consideration of significant environmental issues and potential impacts of proposals. This Act is likely to be repealed by the proposed Environment Protection Bill 1998.

- *Endangered Species Protection Act 1992*

This Act provides a mechanism to list native species as vulnerable, endangered or presumed extinct. The Act obligates the preparation of recovery plans for listed species, and provides funding for the preparation of plans by State governments. The Act legislates for conservation orders and conservation agreements on private land to protect listed species and obliges the Commonwealth Government to give financial assistance to parties of a conservation agreement. The Act creates a permit system for people who wish to take listed native species, and enacts the Endangered Species Advisory Committee and the Endangered Species Scientific Subcommittee to advise the Minister for Environment on endangered species.

Table 10. Agency roles and responsibilities in Western Australia.

AGENCY	KEY ROLE	SECTOR	ACTS/ POLICIES	FUNCTIONS OF ACTS AND POLICIES
Aboriginal Affairs Department	Promotes Aboriginal social and economic development	Indigenous	<i>Aboriginal Affairs Planning Authority Act 1972</i>	<ul style="list-style-type: none"> Established the Aboriginal Affairs Planning Authority and the Aboriginal Lands Trust to manage lands ‘on behalf’ of Aboriginal people (currently being dissolved)
			<i>Aboriginal Communities Act 1979</i>	<ul style="list-style-type: none"> Allows proclamation of Aboriginal Communities, giving power to grant by-laws and community programs
			<i>Aboriginal Heritage Act 1972</i>	<ul style="list-style-type: none"> Legislates for assessing, listing and protecting sites and items of Aboriginal Heritage (Act under review)
Department of Resources Development	Plan, promote and coordinate responsible development of the State’s resources	Government	Fostering Resources Development Program	<ul style="list-style-type: none"> Planning for major projects Proposes policy to assist resource development industries
			Securing Resource Development Program	<ul style="list-style-type: none"> Promotes WA’s potential to development companies Aims to streamline approval process
Conservation and Land Management	Terrestrial: protected area management, forestry, wildlife conservation and exotic pest management, Marine: marine protected area management (shared with Fisheries WA)	Environment	<i>Conservation and Land Management Act 1984</i>	<ul style="list-style-type: none"> Legislates for National Parks and Nature Conservation Authority and Lands and Forests Commission
			<i>Acts Amendment (Marine Reserves) Act 1997</i>	<ul style="list-style-type: none"> Created the Marine Parks and Reserves Authority and the Marine Park and Reserves Scientific Advisory Committee
			<i>Wildlife Conservation Act 1950</i>	<ul style="list-style-type: none"> Conservation of native animals, declaration of protected animals, legislates for licensing people dealing in native flora and fauna, gives wildlife officers enforcement powers
			Salinity Action Plan	<ul style="list-style-type: none"> Cooperative program developed by CALM, AgWA, WRC and DEP Aims to reduce salinity through land-use planning and tree-planting programs
Department of Land Administration	Administers Land titles in WA	Government	<i>Land Act 1933</i>	<ul style="list-style-type: none"> Legislates for the disposal of Crown lands either by leasehold or fee simple for private or public purposes
			<i>Land Administration Act 1997</i>	<ul style="list-style-type: none"> Legislates for the sale or compulsory acquisition of Crown land (Land Act 1933 may be repealed)
Department of Environmental Protection	Assists the EPA in the EIA process. Administers discharge and licenses, prosecutes polluters	Environment	<i>Environment Protection Act 1986</i>	<ul style="list-style-type: none"> Establishes licence arrangements for discharge and emission of waste, radiation and noise Establishes enforcement powers for pollution licensing, includes schedule of penalties for breaching the Act
			Salinity Action Plan	<ul style="list-style-type: none"> Cooperative program developed by CALM, AgWA, WRC and DEP. This Plan aims to reduce salinity through Land use planning and tree planting programs
Environmental Protection Authority	Assessment of development proposals for potential environmental impacts. Develops environment protection policies	Environment	<i>Environmental Protection Act 1996</i>	<ul style="list-style-type: none"> Establishes EIA framework for WA Creates Environmental Protection Authority to administer EIA process, prepare environment protection policies, conduct state-of-environment reporting
			North West Shelf Marine Environmental Management Study	<ul style="list-style-type: none"> Provide information on the long-term sustainability of the North West Shelf region
Transport WA	Implement regional transport strategies, responsible for management of regional ports	Transport & Infrastructure	<i>Pollution of Waters by Oil and Noxious Substances Act 1987</i> <i>Western Australian Marine (Sea Dumping) Act 1981</i>	<ul style="list-style-type: none"> Transport WA is responsible for responding to marine oil pollution events Restricts waste disposal at sea

AGENCY	KEY ROLE	SECTOR	ACTS/ POLICIES	FUNCTIONS OF ACTS AND POLICIES
Main Roads WA	Development and maintenance of WA road network and infrastructure	Transport & Infrastructure	<i>Main Roads Act 1930</i>	<ul style="list-style-type: none"> Legislates for Commissioner to build a network of main roads, to provide contracts for construction and maintenance works, and for controlling access to and use of main roads creates Main Roads Advisory Board
Department of Minerals and Energy	Promotes and regulates mineral and petroleum extractive industries	Minerals & Energy	<i>Mining Act 1978</i> <i>Petroleum (Submerged Lands) Act 1982</i>	<ul style="list-style-type: none"> Sets out consent procedures for mining on private land and different classifications of Crown land Issues licences for prospecting and exploration and leases for mineral production Provides similar framework for managing offshore petroleum resources to Commonwealth Act of same name. Establishes Joint Management authorities
Ministry for Planning		Government	<i>Town Planning and Development Act 1928</i>	<ul style="list-style-type: none"> Legislates for town planning schemes
WA Planning Commission	Decision-making body for State-wide land-use planning	Government	<i>Western Australian Planning Commission Act 1985</i>	<ul style="list-style-type: none"> Developed State Planning Strategy WAPC is developing Kununurra-Wyndham Area Development Strategy
Agriculture WA	Development and management of agricultural industries	Agriculture Pastoral	Sustainable Rural Development Program <i>Soil and Land Conservation Act 1945</i>	<ul style="list-style-type: none"> Approves Landcare funding for community programs in WA, including projects promoting sustainable agriculture and land-use planning Incorporates AgWA's involvement in the Salinity Action Plan (see listing under CALM) Includes AgWA's involvement in new and existing irrigation schemes in the Kimberley region Includes property management planning Legislates for land management measures to attain and maintain an appropriate level of land use and stability of land in perpetuity Establishes Soil and Land Conservation Council
Department of Local Government	Prepares legislation and policy on matters affecting local government	Government	<i>Local Government Grants Act 1978</i> <i>Local Government Act 1995</i>	<ul style="list-style-type: none"> Establishes Local Government Grants Commission to allocate Commonwealth general-purpose grants to local Governments Defines local government boundaries Provides local governments with obligations and powers such as passing by-laws, collecting rates and the ability to order visually polluted land to be cleaned up
Department of Commerce and Trade	Promotes economic development including regional economic development; includes the WA Office of Aboriginal Economic Development	Government	<i>Regional Development Commissions Act 1993</i>	<ul style="list-style-type: none"> Creates Regional Development Commissions, including the Kimberley Development Commission, for sponsoring development in the Shires of Broome, Derby-West Kimberley, Halls Creek and Wyndham-East Kimberley The Act sets out the roles of RDCs: to develop and diversify the economies of regional Western Australia, cooperate with businesses and monitoring the provision of Government services

AGENCY	KEY ROLE	SECTOR	ACTS/ POLICIES	FUNCTIONS OF ACTS AND POLICIES
Fisheries WA	Management of fisheries in State waters and fisheries managed under joint authority with NT and Commonwealth	Fisheries	<i>Fish Resources Management Act 1994</i>	<ul style="list-style-type: none"> • Allows for declaration of fisheries according to a management plan • Establishes licensing arrangements and other management tools • Creates management advisory committees • Allows for joint authorities
			<i>Pearling Act 1990</i>	<ul style="list-style-type: none"> • Establishes licensing and permit arrangements including diving, collection and boat licences • Establishes Pearling Industry Advisory Committee • Legislates for joint management authorities
			<i>Acts Amendment (Marine Reserves) Act 1997</i>	<ul style="list-style-type: none"> • Regulates fishing, aquaculture and mining in marine reserves • Establishes Marine Parks and Reserves Authority
Western Australia Tourist Commission	Promotes Tourism in WA	Tourism	<i>Western Australia Tourism Commission Act 1983</i>	<ul style="list-style-type: none"> • Establishes WATC as principal government agency to develop and promote tourism in Western Australia
Minister for Water Resources	Waters & Rivers Commission -Management of ground - and surface-water resources	Government	<i>Water and Rivers Commission Act 1995</i>	<ul style="list-style-type: none"> • Establishes Water and Rivers Commission as management and research organisation for water resources in WA • Allows the commission to grant bore licenses without the involvement of the Office of Water Regulation or the Water Corporation • Coordinating agency of Salinity Action Plan
			<i>Water Services Coordination Act 1995</i>	<ul style="list-style-type: none"> • Establishes Office of Water Regulation as a regulating agency • Allows it to subsidise farm water infrastructure through the Farm Water Grants Scheme
			<i>Water Corporation Act 1995</i>	<ul style="list-style-type: none"> • Supplies water for domestic and commercial use and provides wastewater services to most water users • Owns some irrigation infrastructure in the Ord River Irrigation Area
Kimberley Land Council	Address issues facing Kimberley Aboriginal people	Indigenous	Established May 1978, received formal recognition under <i>Native Title Act 1993</i>	<ul style="list-style-type: none"> • Represents Indigenous peoples in Kimberley region • Fulfils role of Representative Body under <i>Native Title Act 1993</i>

Table 11. Agency roles and responsibilities in the Northern Territory.

AGENCY	KEY ROLE	SECTOR	ACTS/POLICIES	FUNCTIONS OF ACTS AND POLICIES
Office of Aboriginal Development	Coordinating Government policy on service provision for Aboriginal people	Indigenous	Policy and Development Program	<ul style="list-style-type: none"> Aims to increase Aboriginal involvement in decision-making Promotes whole-of-Government responses to issues affecting Aboriginal people
			Communication and Liaison Program	<ul style="list-style-type: none"> Aims to foster communication between Aboriginal organisations and government departments
Department of Chief Minister	Policy coordination, NT Government response to Native Title	Government	<i>Remuneration (Statutory Bodies) Act</i>	<ul style="list-style-type: none"> Provides for the payment of sitting fees and expenses to members of statutory bodies
			<i>Validation of Titles and Actions Act</i>	<ul style="list-style-type: none"> Validates under section 19 of the <i>Native Title Act 1993</i> (C'th), past acts invalidated by Native Title
			<i>Confirmation of Titles to Land (Request) Act</i>	<ul style="list-style-type: none"> Requests the Commonwealth to enact legislation relating to the rights of Aboriginal inhabitants of Australia in or in relation to land in the Territory
Department of Lands, Planning and Environment		Government	<i>Environmental Assessment Act 1982</i>	<ul style="list-style-type: none"> Establishes EIA processes in NT
			<i>Soil Conservation and Utilisation Act 1978</i>	<ul style="list-style-type: none"> Prevention of soil erosion; allows the passing of soil conservation orders to halt land-use practices that degrade soils
			<i>Crown Lands Act 1992</i>	<ul style="list-style-type: none"> Sets up framework for granting leases and titles
			<i>Planning Act 1993</i>	<ul style="list-style-type: none"> Establishes land-use planning and procedures for development approval
			<i>Pastoral Land Act 1992</i>	<ul style="list-style-type: none"> Management and conservation of pastoral land, including feral animal control and land rehabilitation Clarifies public access to areas under pastoral lease, and arrangements for recognising Aboriginal community living areas within areas under pastoral lease
Parks & Wildlife Commission	Management of protected areas, conservation, wildlife protection	Environment	<i>Parks and Wildlife Commission Act 1995</i>	<ul style="list-style-type: none"> Establishes Parks and Wildlife as lead agency for management of protected areas and wildlife
			<i>Territory Parks and Wildlife Conservation Act 1978</i>	<ul style="list-style-type: none"> Legislates for the declaration and management of protected areas Provides for conservation agreements for private land Potential for management of protected areas in conjunction with Aboriginal Land Councils Declares classification and protection scheme for threatened species, trading of native animals, pest control
Department of Transport and Works	Develops and manages infrastructure for transport and public works	Transport & Infrastructure	<i>Marine Act 1981</i>	<ul style="list-style-type: none"> Regulates shipping, allows conditions to be set on manner of shipping live animals
Department of Mines & Energy	Promotes and regulates mining industries in Northern Territory and in offshore waters under joint authority with the Commonwealth	Minerals & Energy	<i>Mining Act 1980</i>	<ul style="list-style-type: none"> Licensing arrangements and conditions for mining operations Deals with compensation to be paid to holders of pastoral leases and holders of Native Title to mining areas
			<i>Petroleum Act 1984</i>	<ul style="list-style-type: none"> Regulates extraction of terrestrial petroleum supplies, legislates for compensation to Native Title holders over affected lands
			<i>Petroleum (Submerged Lands) Act 1981</i>	<ul style="list-style-type: none"> Establishes basis for joint authorities to manage and regulate offshore petroleum industries
			<i>Uranium Mining (Environment Control) Act 1979</i>	<ul style="list-style-type: none"> Legislates for placing conditions on uranium mining to minimise environmental damage

AGENCY	KEY ROLE	SECTOR	ACTS/POLICIES	FUNCTIONS OF ACTS AND POLICIES
Department of Primary Industries & Fisheries	Management of primary industries and fisheries in and adjacent to Northern Territory	Primary Industries	<i>Fisheries Act 1995</i>	• Legislates for management plans, advisory committees, licensing arrangements and joint authorities
			<i>Biological Control Act 1986</i>	• Regulates the biological control of pest species
			<i>Agricultural and Veterinary Chemicals (Northern Territory) Act 1994</i>	• Applies principles of ESD to the regulation of chemical products in agriculture
			<i>Noxious Weeds Act 1963</i>	• Declaration and eradication of pest plants
Department of Housing and Local Government	Distributes funding to municipal councils, community government councils and 'incorporated association councils'; provides public housing	Government	<i>Local Government Act 1993</i>	• Establishes the different types of local authorities in NT and procedures for electing councillors, charging rates and passing by-laws
Northern Land Council/Central Land Council	Representative bodies to promote Aboriginal rights, protection and use of Aboriginal land	Indigenous	<i>Aboriginal Land Rights (Northern Territory) Act 1976 (Com)</i>	• Recognises Northern Land Council as official voice of Aboriginal people for the management of Aboriginal land
			<i>Aboriginal Land Act 1980 (NT)</i>	• Controls non-Aboriginal access to Aboriginal Land and surrounding seas
NT Tourism Commission	Promotes Tourism in Northern Territory	Tourism	<i>Northern Territory Tourist Commission Act 1979</i>	• Establishes Tourist Commission to promote tourism in NT to advise Minister for Tourism

Table 12. Agency roles and responsibilities in Queensland.

AGENCY	KEY ROLE	SECTOR	ACTS/POLICIES	FUNCTIONS OF ACTS AND POLICIES
Department of Premier and Cabinet	Implement Government policy	Government	<i>State Development and Public Works Organisations Act 1971</i>	<ul style="list-style-type: none"> • Environmental assessment of development proposals • Can override other impact assessment legislation where development might significantly affect existing infrastructure or Queensland economy
			<i>Native Title Act 1993 (Qld)</i>	<ul style="list-style-type: none"> • Lead agency for Government's policy response to Native Title • Negotiations over major projects affecting State
Department of State Development	Coordination of development planning & environmental management Includes the Queensland Tourist and Travel Corporation	Government	<i>State Development and Public Works Organisations Act 1971</i>	<ul style="list-style-type: none"> • Requires Government bodies to be mindful of environmental impacts of developments • Legislates for the Department to demand or omit environmental impact assessment on projects
			Queensland Aboriginal and Torres Strait Islander Economic Development Strategy	<ul style="list-style-type: none"> • Strategy for sustainable economic development concerned with education, employment, business and industry
Department of Communication Information, Local Government and Planning	Interacts between State Government and local Governments, helps define the roles of local governments, approves planning schemes	Government	<i>Integrated Planning Act 1997</i>	<ul style="list-style-type: none"> • Framework for local and State government planning and development assessment to be reflected in local planning schemes • Includes economic, environmental and social
			<i>Local Government (Planning and Environment) Act 1990</i>	<ul style="list-style-type: none"> • Primary legislation controlling planning and development through local government Previously Department of Local Government and Planning
			<i>Local Government (Aborigines) Act</i>	<ul style="list-style-type: none"> • Establishes Shires corresponding to Indigenous communities: eg. created Mornington Shire
Department of Mines and Energy	Management of State mineral resources, coal, oil, gas & electricity distribution	Minerals & Energy	<i>Mineral Resources Act 1989</i>	<ul style="list-style-type: none"> • Regulates mineral development • Sets out development-approval processes and timelines • EIA can be instigated under the Act
			<i>Offshore Minerals Act 1998</i>	<ul style="list-style-type: none"> • Legislates for joint authorities for the management of offshore mineral resources, titles system involving exploration permits and mineral development leases, permit and lease conditions, royalty payments • Clarify the boundaries of State/Federal jurisdiction
			<i>Petroleum Act 1923</i>	<ul style="list-style-type: none"> • Establishes titles for petroleum and gas exploration and extraction in Queensland
			<i>Petroleum (Submerged Lands) Act 1982</i>	<ul style="list-style-type: none"> • Establishes joint-authorities for the management of petroleum outside of State waters
			<i>Electricity Act</i>	<ul style="list-style-type: none"> • Department of Mines and Energy is responsible for managing electricity production & distribution under this Act for commercial, industrial and private consumption

AGENCY	KEY ROLE	SECTOR	ACTS/ POLICIES	FUNCTIONS OF ACTS AND POLICIES
Department of Natural Resources	Manages land, water & native forests, amalgamation of functions of the previous Departments of Lands and Primary Industries	Agriculture Environment Pastoral	<i>Water Resources Act 1989</i>	<ul style="list-style-type: none"> Water-resource allocation Protection of river systems Establishment and management of irrigation
			<i>Land Act 1994</i>	<ul style="list-style-type: none"> Use and development of Crown land Administration of titles, including tree-clearing guidelines under s.262
			<i>Draft Natural Resource Management Bill</i>	<ul style="list-style-type: none"> Management of State-owned or controlled, or privately controlled natural resources Replaces <i>inter alia</i> <i>Water Resources Act, Forestry Act, Soil Conservation Act</i>
			<i>Native Title Act 1993</i>	<ul style="list-style-type: none"> Administers land titles, makes information available on land titles, has authority to transfer titles
			Gulf Regional Water Resources Planning and Assessment Study	<ul style="list-style-type: none"> Addresses water-resources development issues, focusing on irrigated agriculture and the needs for mining and urban water supplies
Department of Primary Industries	Responsibility for forestry, agriculture and fisheries R&D	Fisheries Agriculture	<i>Fisheries Act 1994</i>	<ul style="list-style-type: none"> Legislates for Management and Zonal Advisory Committees Establishes Queensland Fisheries Management Authority, Fisheries Tribunal Legislates for the preparation of management plans, permits, licences and quotas, species restrictions, gear restrictions and other management tools
Department of Environment and Heritage	Responsibility for national parks, conservation strategies, coastal management and cultural heritage, pollution, environmental planning and waste management	Environment	<i>Environment Protection Act 1994</i>	<ul style="list-style-type: none"> Air, noise and water quality protection, waste management Legislates for Environment Protection Policies
			<i>Nature Conservation Act 1992</i>	<ul style="list-style-type: none"> Flora and fauna conservation throughout Queensland Endangered species protection National park management
			<i>Coastal Protection and Management Act 1995</i>	<ul style="list-style-type: none"> Coastal protection and management Provision for development of coastal management plans
			<i>Cultural Records (Landscapes Queensland & Queensland Estate) Act 1986</i>	<ul style="list-style-type: none"> Protection of Aboriginal sites Establishes a register and permit system for cultural heritage
Queensland Transport	Overall planning of transport system, integrated planning	Transport & Infrastructure	<i>Transport Infrastructure Act 1994</i>	<ul style="list-style-type: none"> Some powers for land acquisition Management of public infrastructure (eg. pipelines, ports and powerlines) Establishes Ports Corporation Queensland
			<i>Transport Planning and Coordination Act 1994</i>	<ul style="list-style-type: none"> Legislates for Transport Coordination Plan
Department of Main Roads	Development of road network	Transport & Infrastructure	Maintains/upgrades road network	<ul style="list-style-type: none"> Developing Barkly Highway from Cloncurry to NT border
Department of Families, Youth and Community Care	Includes the Office of Aboriginal and Torres Strait Islander Affairs lead agency role for SIA in Queensland	Human & Social	Indigenous Land Interest Model (Draft)	<ul style="list-style-type: none"> Triggered by State Development and Public Works Organisations Act, Mineral Resources Act & Local Government (Planning and Environment) Act Provides for effective participation of Indigenous peoples in impact assessment processes
			<i>Community Services (Aborigines) Act 1984</i>	<ul style="list-style-type: none"> Establishes Aboriginal Community Councils (Doomadgee, Kowanyama)

AGENCY	KEY ROLE	SECTOR	ACTS/POLICIES	FUNCTIONS OF ACTS AND POLICIES
Ports Corporation Queensland	Operates single product/bulk export facilities (Karumba)	Transport & Infrastructure	<i>Transport Infrastructure Act 1994</i>	<ul style="list-style-type: none"> Legislates for management and planning of transport infrastructure Establishes port authorities, defines port limits Establishes principles for management of port land Legislates for arrangements with local governments to construct works of transport infrastructure
Carpentaria Land Council	Address issues facing Gulf Aboriginal people	Indigenous	Established 1985, received formal recognition under <i>Native Title Act 1995</i>	<ul style="list-style-type: none"> Represents Indigenous peoples in Gulf region Fulfils role of Representative Body under Native Title Act
Cape York Land Council	Address issues facing Cape Aboriginal people	Indigenous	Established 1991, received formal recognition under <i>Native Title Act 1993</i> in 1994	<ul style="list-style-type: none"> Represents Indigenous peoples in Cape York region Fulfils role of Representative Body under Native Title Act
Queensland Fisheries Management Authority	Ensure appropriate management, use, development & protection of in-shore fisheries	Fisheries	<i>Fisheries Act 1994</i>	<ul style="list-style-type: none"> Fisheries management Research and Development

Table 13. Commonwealth agency roles and responsibilities in tropical Australia.

AGENCY	KEY ROLE	SECTOR	ACTS/POLICIES	FUNCTIONS OF ACTS AND POLICIES
Department of Environment and Heritage – Environment Australia				
Biodiversity Group	Establishes and maintains management programs to protect biodiversity	Environment	<i>Endangered Species Protection Act 1992</i>	<ul style="list-style-type: none"> Promotes recovery of vulnerable or endangered species/communities and the prevention of species becoming endangered This Act is likely to be repealed if the Biodiversity Protection Bill is passed
			<i>National Heritage Trust Act 1997</i>	<ul style="list-style-type: none"> Establishes and allows for administering the Natural Heritage Trust. Currently funds five environmental management programs and approval guidelines for further programs
			<i>Australian Heritage Commission Act 1975</i>	<ul style="list-style-type: none"> Identification and protection of items/places of cultural, environmental, architectural and historical significance Legislates for the Register of the National Estate
			<i>Biodiversity Conservation Bill 1998</i>	<ul style="list-style-type: none"> Proposes to replace existing Commonwealth wildlife conservation and environmental management legislation with a single, integrated Act Proposes more defined roles for the Commonwealth and States and emphasises bilateral agreements Proposes a framework for conservation agreements, the management of nationally and internationally significant protected areas, conservation plans in conjunction with State management programs, protection of endangered species and a monitoring role for the Commonwealth
Environment Protection Group	Assesses Environmental Impacts, monitors air and water quality	Environment	<i>Environment Protection (Impact of Proposals) Act 1974</i>	<ul style="list-style-type: none"> Controls EIA and decision-making of Commonwealth departments and agencies by requiring consideration of significant environmental issues This Act is likely to be repealed if Environment Protection Bill is passed
			<i>Environment Protection Bill 1998</i>	<ul style="list-style-type: none"> Proposes to replace the <i>Environment Protection (Impact of Proposals) Act 1974</i> Removes some triggers to EIA at a Commonwealth level, being applied only according to a 'tightly defined test of national environmental significance'. Subordinate to State decisions in some circumstances
Portfolio Marine Group	Management of coastal and marine resources	Fisheries	<i>Environment Protection (Sea Dumping) Act 1981</i>	<ul style="list-style-type: none"> Regulates dumping of waste at sea & includes dredge material, prohibits dumping of radioactive waste Act does not apply to Australian Defence Forces
			Australia's Oceans Policy	<ul style="list-style-type: none"> Protection of offshore biodiversity and management of ocean resources Includes studies on multiple-use management, marine resource allocation, the role of collaborative management and stewardship and Aboriginal and Torres Strait Islander interest in saltwater country
ERISS	Conduct research on the Alligator Rivers Region	Research & Development	<i>Environment Protection (Alligator Rivers Region) Act 1978</i>	<ul style="list-style-type: none"> Development of techniques to detect and minimise the environmental impacts of uranium mining
Department of Industry, Science and Resources				
Energy and Resources Group	The Petroleum Division	Minerals & Energy	<i>Petroleum (Submerged Lands) Act 1967</i>	<ul style="list-style-type: none"> Governs offshore petroleum exploration and extraction to the outer limit of the continental shelf Governs permits for exploration and licenses for petroleum recovery and sets conditions on permit/license approval Establishes basis for joint State/Commonwealth management authorities
	Coal and Mineral Industries Division		<i>Offshore Minerals Act 1994</i>	<ul style="list-style-type: none"> Allows for Commonwealth–State Joint Authorities to regulate offshore mineral exploration and recovery beyond State coastal waters

AGENCY	KEY ROLE	SECTOR	ACTS/POLICIES	FUNCTIONS OF ACTS AND POLICIES
Australian Geological Survey Organisation	The Minerals Division geological mapping throughout Australia	Minerals & Energy	National Geoscience Mapping Accord	<ul style="list-style-type: none"> Geo-mapping initiative resulting in datasets and modelling to encourage mineral and petroleum exploration and development in Australia
	The Marine Division assesses petroleum and gas resources, includes focus on marine environment		Australian Ocean Territory Mapping Program	<ul style="list-style-type: none"> Component of the National GeoScience mapping Accord, which focuses on the North West Shelf region
	The Geohazards, Land and Water Division Conducts hydrology research		Law of the Sea Program	<ul style="list-style-type: none"> Assists in developing policy on marine boundaries and policy for the recovery of minerals/petroleum
Agriculture, Fisheries and Forestry – Australia				
Fisheries Australia	Development of strategic policy for fisheries management in Australia	Fisheries	<i>Fisheries Management Act 1991</i>	<ul style="list-style-type: none"> Management of fisheries in Commonwealth waters Establishes the Australian Fisheries Management Authority. Requires management plans for declared fisheries Legislates for management tools such as permits, licences, gear restrictions, quantity restrictions, seasonal closures, species restrictions Prohibits driftnet fishing Legislates for provision of foreign fishing rights
Agriculture and Forests Group	Land and Water Resources Division	Government	Natural Resource Management Program	<ul style="list-style-type: none"> Distributes NHT funding towards the sustainable management of land and water resources Implements COAG Water Reform Policy across States Promotes a national campaign for Property Management Planning
Department of Prime Minister and Cabinet	Responsibility for policy coordination at Commonwealth level	Government	<i>Aboriginal and Torres Strait Islander Heritage Protection Act</i>	<ul style="list-style-type: none"> Protects areas and objects of significance to Indigenous peoples from injury or desecration. Includes items/places in Australian waters Minister may issue declarations for the preservation of significant Aboriginal objects and may issue emergency declarations for objects under immediate threat
Department of Defence	Security of Australia	Government	Not publicly available	<ul style="list-style-type: none"> Not publicly available
Department of Transport and Regional Development	Provide the economic, environmental and social infrastructure necessary for Australia's regions to realise their potential	Transport & Infrastructure	Regional Australia Strategy	<ul style="list-style-type: none"> Coordinates Federal initiatives to develop employment and business; enhanced infrastructure including telecommunications; improving services in regional Australia; environmental sustainability (through NHT)
Aboriginal and Torres Strait Islander Commission	Administers programs for Indigenous peoples, economic & regional development, housing, legal, land, social justice & employment	Indigenous	<i>Native Title Act 1993</i> <i>Native Title Amendment Act 1998</i>	<ul style="list-style-type: none"> Established mechanisms for recognition and protection of Native Title Established the National Native Title Tribunal the Indigenous Land Corporation and Native Title Representative Bodies
Indigenous Land Corporation	Assists Indigenous peoples acquire and manage land	Indigenous	<i>Land Fund and Indigenous Land Corporation (ATSIC Amendment) Act 1995</i>	<ul style="list-style-type: none"> Makes amendments to the <i>Aboriginal and Torres Strait Islander Commission Act 1989</i> to establish the ILC as responsible for the Indigenous Land Fund and the National Indigenous Land Strategy The Land fund is enacted to assist Indigenous peoples acquire and manage land sustainably

3.3.2 Local Government

Local government plays a key role in natural resource management the study region. These roles include (Graham, 1993):

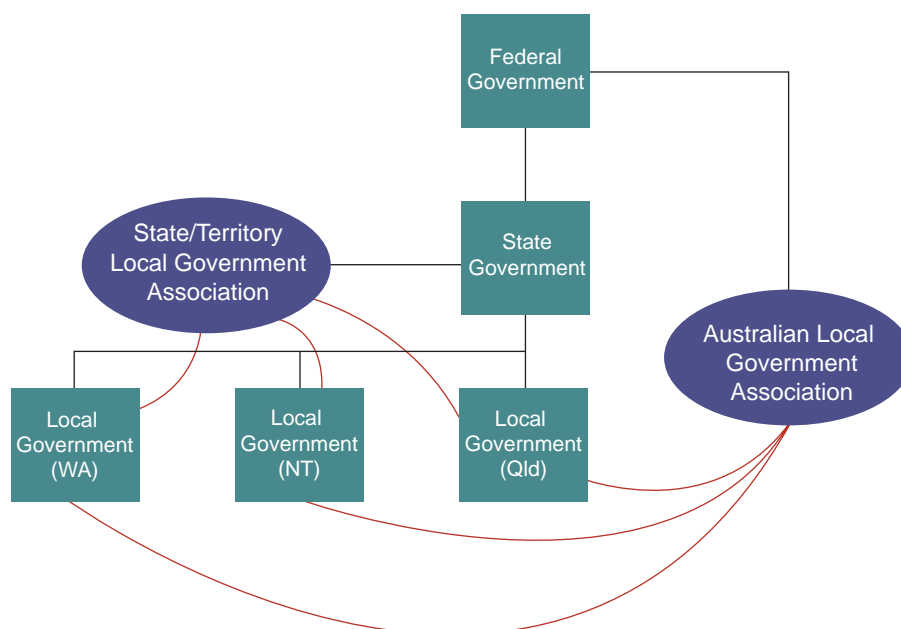
- regulation of development on private land;
- preparation and review of land-use plans; and
- development of infrastructure such as waste treatment plants and roads

In addition, local government undertakes significant interaction with local interest and community groups, particularly identifying regional priorities and voicing local knowledge (WAMA, 1998:19). Local governments are also frequently involved in community projects through programs such as Landcare.

Increasingly, local government is being required by State and Federal agencies not only to participate in natural resource management but also to assume a broader role in administering natural resource management activities (Johnson *et al.*, 1997; Sproats and Kelly, 1998). However, meeting these expectations has proven to be difficult. Intergovernmental relations have been described as hierarchical and feature a low level of interaction (Graham, 1993; WAMA, 1998). The Australian Local Government Association (ALGA) has noted that in some cases, local government is responsible for implementing State government policies and programs without much control in their development. Overall, local governments believe they do not receive due regard as potential representatives of local interests, and as, as one of the three spheres of government, legitimate natural resource managers. This lack of recognition has led to poor resourcing for natural resource management issues and the belief that local government programs are neither recognised nor supported by other spheres of government (ALGA, 1992; WAMA, 1998).

Local governments interact with two significant types of organisation. The first of these are State departments of local government such as the Queensland Department of Communication, Information, Local Government and Planning. The second significant type interaction is with local government associations such as ALGA. Figure 7 illustrates these relationships.

Figure 7. Relationship between local, State and Commonwealth government.



There is substantial diversity between the roles and responsibilities of local government in the study area due to:

- the size of the area and population represented;
- range and scale of functions performed;

-
- budget and resources available;
 - physical, economic, social and cultural environments of local government areas;
 - structures of power within the local government area; and
 - differing legislative frameworks.

Queensland

Local government in the study region provides the primary vehicle for planning activities. This role has recently undergone significant change through the passing of the *Integrated Planning Act (1997)*. Together with the more 'common' form of local government, two others relate to the Aboriginal communities of Mornington Island, Doomadgee and Kowanyama. The Shire of Mornington was created by the *Local Government (Aboriginal Land) Act (1978)*. The second form of local governance came into being under the *Community Services (Aborigines) Act 1984* and covers over 14 former Aboriginal reserves. They include Doomadgee, Kowanyama and Pormpuraaw. The Community Councils have become trustees of land included in Deed of Grants in Trust (DOGIT) under the *Land Act (Aboriginal and Islander Land Grants) Amendment Act 1982*. The responsibilities of the community councils far exceed those of a 'normal' shire and include housing provision and management, community policing and the running of canteens, stores, service stations and farms.

Queensland, therefore, has three types of local government within the study area. The Queensland Department of Communication, Information, Local Government and Planning maintains and updates the legislative framework for local government, and administers financial grants to local governments and Aboriginal and Torres Strait Islander Councils for the purposes of developing and maintaining infrastructure (DTSBI, 1996). The department is supposed to ensure that local planning is consistent with regional and State planning schemes. Unlike Western Australia, where State and local government planning are addressed through different approaches, the department is responsible for both these roles. The principal planning initiatives of the department relevant to this study are the Gulf Regional Development Plan, discussed elsewhere in this report. Local government bodies in the Gulf of Carpentaria have collaborated on issues of mutual significance, such as the Gulf Regional Development Plan, and are also involved with the Queensland Department of Natural Resources on water management issues (GLADA, 1997).

The Local Government Association of Queensland was formed in 1986 to represent local governments in lobbying the State Government as well as interacting with unions, business and the community. Its objectives are to promote the interests, rights and entitlements of members, to promote the efficient performance of local government in Queensland, to monitor and take action in relation to any legislation affecting members and to advise and counsel members in matters of doubt or difficulty.

Northern Territory

Local government in the Northern Territory plays a much lesser role in natural resource management than in other parts of the study area. The Northern Territory Department of Housing and Local Government administers the *Local Government Act 1993*. This includes assisting communities become incorporated as local government councils, providing advice and support to local councils as well as monitoring compliance by councils to the Act and its accompanying regulations. One of the most important roles of the Local Government Division is providing funding to local governments through grants. In addition, the division maintains the legislative and policy framework for local government and is responsible for community development and community planning assistance. Finally, the division serves as a medium for the exchange of information and advice between communities and the Territory and Commonwealth governments.

The Department interacts closely with the Northern Territory Grants Commission which makes recommendations to the Minister for Local Government in respect of the amounts of money to be allocated to local governing bodies from the money provided to the Territory by the Commonwealth under the *Local Government (Financial Assistance) Act 1986 (C'th)*.

The NTDHLG administers three Acts

- *Local Government Act 1993*
- *Local Government Grants Commission Act 1986*
- *Local Government (Validation) Act 1996*

The Local Government Association of the Northern Territory evolved following the advent of self government in the Northern Territory in 1978 and received statutory recognition with the passing of the *Local Government Act (NT)*. The association represents its member councils and lobbies governments on issues such as funding for local governments. The association provides advice on best practice procedures and works in cooperation with the Territory Government to provide a service for disseminating information between local governments and feedback on local government issues.

Western Australia

The Western Australian Department of Local Government is the institutional and funding link between the State Government and all the local Governments in Western Australia. This department prepares legislation enabling and obliging local governments to govern in particular ways. The Department is responsible for reviewing individual local governments' financial statements and legislative compliance and monitors the procedure and content of local laws being passed by local governments (WADLG, 1997). The Department is closely linked to the Local Government Grants Commission which allocates funding for Commonwealth general purpose grants (WADLG, 1997).

WADLG administers the following Acts:

- *Local Government Act 1995*
- *Local Government (Miscellaneous Provisions) Act 1960*
- *Control of Vehicles (Off-Road Areas) Act 1978*
- *Local Government Grants Act 1978*

The Western Australian Municipal Association represents local governments in Western Australia in discussions with the Australian Local Government Association and with the WA Department of Local Government. Its most relevant initiative is the 'Draft Local Government and Natural Resource Management: Mechanisms Available for the Protection and Management of Bushland and Wetlands', released for discussion in July 1998 (WAMA, 1998). This document outlines aspects of the *Local Government Act 1995* which allow local governments to manage and protect wetlands and bushland in their shires. It also voices the opinion that local government representation on issues affecting local governments is essential for an integrated approach to natural resource management (WAMA, 1998).

Australian Local Government Association (ALGA)

ALGA represents the combined voice of local governments in dealings with the Commonwealth Government. ALGA aims to increase recognition of local governments as providers of local knowledge and expertise in issues and programs which require strong participation by local government. In so doing, ALGA works to increase local government's share of national taxation revenues through the system of Commonwealth financial assistance grants and other measures.

ALGA provides several core services to local councils throughout Australia. It provides information on national issues, policies and trends affecting local government and it provides guidance on use of the Internet so that local governments can reach their audiences online. The ALGA distributes discussion documents to local governments and documents local government responses to inform negotiations with other spheres of government. A key recent example is the development, in partnership with ATSIC and the NNTT, of a policy guide for local government on negotiating agreements with Native Title holders and integration of Native Title issues in local government.

3.3.3 Non-government Organisations

A large number of non-government organisations (NGOs) are active in natural resource planning and management in the study region. Nearly all of the key sectors in the region have NGO representation. Table 14 lists the key NGOs and briefly describes their roles and responsibilities.

Table 14. Non-government organisations and their roles and responsibilities

NGO Name	Sector	Roles and Responsibilities
Commonwealth		
Australian Conservation Foundation	Government	<ul style="list-style-type: none"> Australia's major national non-government environmental organisation Priority campaigns are: Forests, World Heritage Areas, Healthy Rivers, Save The Bush, Greenhouse, Sustainable Cities, Clean Industry, Trade and the Environment, Cape York Peninsula and the Kimberley.
Australian Local Government Association	Government	<ul style="list-style-type: none"> Represents the combined voice of local governments in dealings with the Commonwealth Government Aims to increase recognition of local governments as important participants in natural resource management.
Australian Seafood Industry Council	Fishing	<ul style="list-style-type: none"> The ASIC is an industry lobby group representing commercial fisherman and the seafood industry in Australia.
National Farmers' Federation	Agriculture	<ul style="list-style-type: none"> Represents Australian farmers in dealings with Commonwealth Government Represents 120,000 farm organisations and their commodity councils Focused on national issues (eg industrial relations, economics , social welfare of farming communities).
Northern Prawn Fishing Industry Organisation	Fishing	<ul style="list-style-type: none"> The NPFIO is an industry lobby group representing prawn fisherman in the Northern Prawn Fishery.
World Wildlife Fund	Environment	<ul style="list-style-type: none"> International organisation conducting conservation programs in Australia Funding of research into the conservation and management of threatened species and habitats Key programs in conservation of the outback and arid lands; wetlands management; conservation of woodlands and forests; protection of native grasslands; conservation of remnant vegetation on agricultural lands; and protection of the marine ecosystem.
Western Australia		
Conservation Council of Western Australia	Environment	<ul style="list-style-type: none"> Umbrella organisation representing 60 volunteer conservation groups in WA Currently focusing on development of the Fitzroy River.
Environs Kimberley	Environment	<ul style="list-style-type: none"> Environmental lobby group concerned with issues relating to the Kimberley environment.
Pastoral and Graziers' Association of Western Australia	Pastoral	<ul style="list-style-type: none"> Represents pastoralists in WA Vocal on the issue of revised government approaches to rangeland management Particularly interested in responding to the National Rangelands Strategy Working Group on representing pastoralists interests in rangeland management.
The Western Australian Farmers Federation	Agriculture	<ul style="list-style-type: none"> Represents approximately 6,000 individual farmers on 5,000 farm enterprises Farmers include wool producers, grain growers, meat producers, horticulturalists and dairy farmers. Member of the NFF Provides a forum for members to influence issues in primary industry sector.
Western Australian Chamber of Minerals and Energy	Minerals and Energy	<ul style="list-style-type: none"> Represents the interests of mining companies in Western Australia Lobbies State Government on issues affecting the minerals sector Aims to increase community understanding of the role of the minerals sector in society.
Western Australian Fisheries Industries Council	Fishing	<ul style="list-style-type: none"> The WAFIC is an industry lobby group representing commercial fisherman, including aquaculture interests, in Western Australia
Western Australian Municipal Association	Government	<ul style="list-style-type: none"> Represents local governments in WA in discussions with the Australian Local Government Association and with the WA Department of Local Government Prepared Report on mechanisms available to Local Government in environmental management Focused on increasing Local Government involvement in natural resource management.
Queensland		
Agforce Queensland	Agriculture	<ul style="list-style-type: none"> Created in 1998 as the result of a merger between The United Graziers Association, the Queensland Cattlemen's Union and the Queensland Grain Growers' Association Lobbies government at a State and Federal level Provides a general body to deal with issues of common concern to primary producers Structure includes three commodity councils and five regional offices.
Cairns and Far North Environment Centre	Environment	<ul style="list-style-type: none"> Lobbies Government to protect natural features of Cape York Peninsula and the Gulf of Carpentaria Aims to increase community awareness on education campaigns on environmental issues.
Queensland Commercial Fisheries Organisation	Fishing	<ul style="list-style-type: none"> The QCFO is an industry lobby group representing commercial fisherman in Queensland.
Queensland Conservation Council	Environment	<ul style="list-style-type: none"> Represents over 50 regional conservation and environment groups throughout Queensland at a State level.

NGO Name	Sector	Roles and Responsibilities
Queensland Mining Council	Minerals and Energy	<ul style="list-style-type: none"> • Represents the interests of mineral producers and explorers in Queensland • Lobbies State Government on issues affecting minerals sector • Distributes information on mining issues to member organisations and distributes educational material to schools.
Sunfish	Fishing	<ul style="list-style-type: none"> • Lobby group representing recreational and sports fisherman in Queensland.
The Local Government Association of Queensland	Government	<ul style="list-style-type: none"> • Peak body formed in 1986. Represents local governments in dealings with State Governments • Advises member councils on matters affecting local government.
Northern Territory		
Amateur Fishermen's Association of the NT	Fishing	<ul style="list-style-type: none"> • Represents the interests of the recreational and sport fishing community in the NT • Main issue of concern is access to fishing grounds for recreational and sport fishers including National Parks.
Environment Centre of Northern Territory	Environment	<ul style="list-style-type: none"> • Volunteer conservation lobby group based in Darwin • Aims to protect the mangroves and catchments of Darwin Harbour and to prevent proposed trade in wildlife.
Local Government Association of the Northern Territory	Government	<ul style="list-style-type: none"> • Represents its member councils and lobbies Governments on issues such as funding for local governments • Provides advice on best practice and a service for disseminating information between local governments.
Northern Territory Cattlemen's Association	Pastoral	<ul style="list-style-type: none"> • Represents beef producers of NT • Lobbies Government on issues affecting members • Aims to promote the development of the cattle industry and land resources of Northern Territory.
Northern Territory Fishing Industries Council	Fishing	<ul style="list-style-type: none"> • The NTFIC is an industry lobby group representing commercial fisherman in NT.
Northern Territory Minerals Council	Minerals and Energy	<ul style="list-style-type: none"> • Represents the collective interests of companies involved in mining, exploration and mineral processing, oil and gas supply in the Northern Territory • Operates as a point of contact for information exchange within the minerals sector. • Promotes the Minerals sector by providing information about the minerals industry to the public.

3.3.4 Natural Resource Planning

Several regional plans have been completed recently in tropical Australia. These are the Kimberley Regional Study Plan, Darwin Regional Land Use Structure Plan, Gulf Region Land Use and Development Study, and the Cape York Peninsula Land Use Strategy (Figure 8).

In reviewing these planning activities Holmes (1996b) and Dale and Bellamy (1998) concluded that they tended to centralise decision-making and were primarily bureaucratic exercises of data collation; lacked system-wide approaches; focused on dualism of Indigenous and non-Indigenous interests; and did not provide resources or processes for capacity development and negotiation of outcomes. Fundamentally, except to some extent for the Cape York process, they occurred largely in isolation from overall development policy process (Holmes, 1996b).

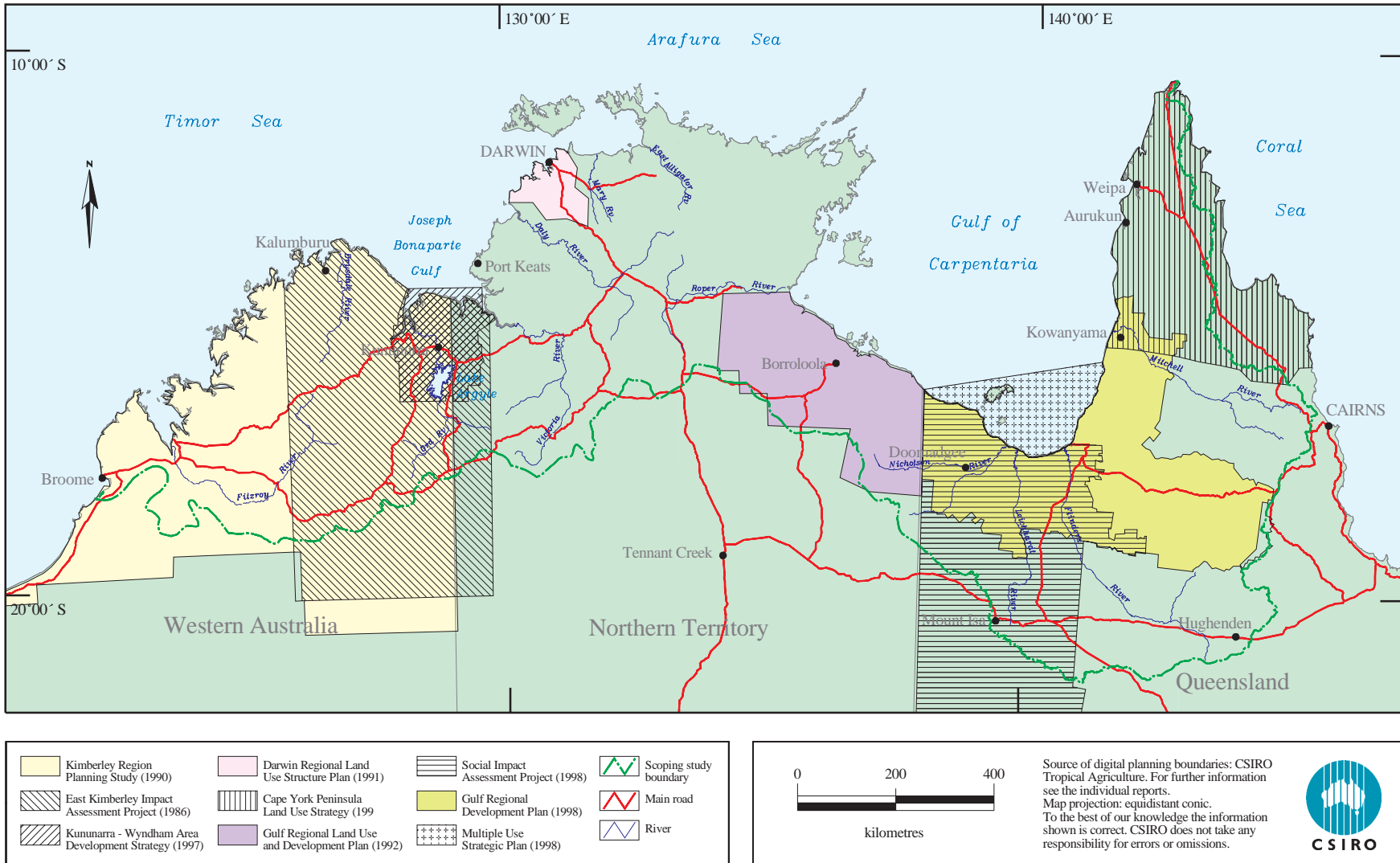
In addition to these, there is an integrated catchment management plan for the Mitchell River catchment on western Cape York peninsula which was driven by the Kowanyama Aboriginal Land and Natural Resource Management Office (KALNRMO) (Carr, 1993), and a 'Caring for Country Strategy' established by the Northern Land Council. The Indigenous Land Corporation has also prepared regional Indigenous land strategies for each State and Territory as well as an integrating national strategy (ILC, 1996a,b,c). All ATSIC regional councils have also developed plans and Native Title Representative Bodies are also working on triennial strategic planning. Various regional, subregional and agency-based plans are also currently being developed in the study area (Table 15).

The lack of integration among regional plans and strategies identified by Holmes (1996b) in previous regional planning processes appears to be continuing. Clearly, planning must be done at multiple scales to respond to particular management needs, but there appears to be no strategic attempt to provide regional perspectives in which these processes can be embedded. Further, the incremental nature of smaller-scale regional planning can mean that the decisions that allow choice, as von Sturmer once noted (1984), are not available for negotiation.

Table 15. Key planning activities and programs in the study area.

NAME	AIM	KEY AGENCIES
NORTHERN TERRITORY		
Darwin 2010 – MultiModal Transport and Logistics Hub	<ul style="list-style-type: none"> Develop Darwin’s role in importing and exporting between northern Australia and South East Asia. Extend and develop the port, push to develop the Darwin to Alice Springs Railway 	NT Department of Asian Relations, Trade and Industry
Northern Territory Parks Masterplan	<ul style="list-style-type: none"> Identify key issues for 15-year plan for developing NT protected area system, & establish framework for developing regional strategies 	NTPWC
Mary River Catchment Management Plan	<ul style="list-style-type: none"> Develop and ICM Plan for the Mary catchment Address issues such as saline intrusion 	NTLPE, NTDIF, NTPWC
Arafura Wetlands Management Plan	<ul style="list-style-type: none"> Developing integrated management plan for the wetlands and surrounding catchment 	Yolngu people of the Arafura wetlands area, CINCRM, NLC Caring for Country Unit
QUEENSLAND		
Gulf of Carpentaria Inshore Finfish Fishery	<ul style="list-style-type: none"> Ensure the sustainability of finfish stocks 	Queensland Fisheries Management Authority
Gulf Regional Development Plan	<ul style="list-style-type: none"> Develop a comprehensive regional development framework for the Gulf of Carpentaria Identify issues for the environment, and economic, social and community development, Environmental issues. 	DCILGP, GLADA
Multiple-Use Strategic Plan for the Southern Gulf of Carpentaria MUSP	<ul style="list-style-type: none"> Establish cooperative and integrated sustainable management and use of natural resources 	Joint C’tth/Queensland project. Steering committee representing Department of State Development, Department of Environment and Heritage, AFFA, EA
Queensland Transport’s North West and Gulf Savannah Transport Study	<ul style="list-style-type: none"> Framework for detailed investigations of road, rail, air and marine infrastructure 	Queensland Transport
Queensland Transport Strategic Plan 1997–2001	<ul style="list-style-type: none"> Facilitate transport solutions for the North West Minerals Province. Provide strategic transport and maritime information database for large economic development projects 	Queensland Transport
Southern Gulf Catchments ICM	<ul style="list-style-type: none"> Sustainable development of the southern gulf catchments Coordinate environment protection and conservation projects 	QDNR, QDEH
Mitchell River Catchment ICM	<ul style="list-style-type: none"> Maintain water quality Encourage conscious and responsible use of the catchment through education Maintain sustainable economic use of resources 	KALNRMO, QDNR, CAFNEC, QDPI,
Social Impact Assessment Project	<ul style="list-style-type: none"> Facilitate sustainable economic development of communities in the Gulf of Carpentaria 	DPC, DFYCC
Water Infrastructure Planning and Development: Gulf Region Study	<ul style="list-style-type: none"> Identify areas with potential for agricultural production in the Gulf Savanna region 	QDNR
WESTERN AUSTRALIA		
Kimberley Aquaculture Development Plan	<ul style="list-style-type: none"> Provide basis for development of commercial aquaculture industry in Kimberley 	Fisheries WA; KDC
Kununurra–Wyndham Area Development Strategy	<ul style="list-style-type: none"> Provide direction for the long-term use and management of the area 	WA MfP, KDC, SWEK NTLPE, WAPC
Lower Ord Land and Water Management Plan	<ul style="list-style-type: none"> Achieve sustainable land and water use in the lower Ord 	OIC, AgWA, KDC, WRC, Water Corp
Planning for Agricultural Land Use	<ul style="list-style-type: none"> Develop a policy for protecting productive agricultural, horticultural and pastoral land 	Agriculture WA, WA MfP
Kimberley Regional Transport Strategy	<ul style="list-style-type: none"> Develop transport system to connect Kimberley region to markets 	Transport WA, KDC
State Planning Strategy	<ul style="list-style-type: none"> State-wide framework for regional planning. Identify land-use planning issues on a regional basis and combine these in a State-wide framework 	WA MfP, WAPC

Figure 8. Selected integrated regional planning processes impacting on the study area.



3.3.5 Marine Resource Policy, Planning and Management

In previous sections we have provided a discursive description of terrestrial resource policy, planning and management, and this information has been summarised in tables. However, given the complexity of marine resource management issues in northern Australia (particularly jurisdictional issues) and the likely audience for this report, we felt it useful to provide a summary of key marine resource institutional and management arrangements.

The very recently released ‘Australia’s Oceans Policy’ (Commonwealth of Australia, 1998) provides the key policy underpinning for marine resource management in Australia. It builds on the principles of ESD to develop an integrated, ecosystem framework for planning and managing Australia’s marine resources. This policy aims to develop regional marine plans, based on large marine ecosystems (see Sherman, 1994), starting with the south-eastern waters of Australia’s Exclusive Economic Zone (including waters off Victoria, Tasmania, southern New South Wales, and eastern South Australia). The strategy outlined in Australia’s Oceans Policy attempts to overcome the problems of planning and management based on single sectors and/or jurisdictional boundaries.

The implementation arrangements for Australia’s Ocean Policy have been outlined in Chapter 3 of the Commonwealth of Australia’s report (1998). Australia’s Oceans Policy will be implemented through four institutions/arrangements that are to be established: National Oceans Ministerial Board; National Oceans Advisory Committee; National Oceans Office; and Regional Marine Plan Steering Committees. These arrangements are being developed to encourage the cooperation and participation of the States and Territories through the Australian and New Zealand Environment and Conservation Council (ANZECC) and the development of Regional Marine Plans.

3.3.5.1 Offshore Constitutional Agreement (OCS)

The legal and constitutional frameworks of Australia’s marine areas have been summarised in Appendix 2 of Australia’s Ocean Policy (Commonwealth of Australia, 1998). During the 1970s and early 1980s, the Commonwealth and the States came to a series of agreements known as the Offshore Constitutional Settlement (the OCS), with the legislation (*Coastal Water States, Power and Title Act* 1982) coming into effect in 1983. The two key elements of the OCS are:

1. The States and the Northern Territory were given title to ‘coastal waters’—all waters landward of the 3 nautical mile limit but not including the internal waters that are within the constitutional limits of a State eg. the Brisbane River.
2. They were given legislative power over coastal waters in the same way as they have over their land territory.

Through the OCS, the Commonwealth has agreed to give the States and Northern Territory primary responsibility over coastal waters. Beyond that, the Commonwealth retains primary responsibility. There are a number of cooperative arrangements in the OCS for the management of fisheries and petroleum.

Australia has also declared four maritime zones under the *Seas and Submerged Lands Act 1973*. The terrestrial border of the zones is measured from the territorial sea baseline, located mostly at the low-water line along the coast. It also consists of bay and river closing lines and some straight lines between the mainland and adjacent islands and across parts of the coast that are deeply indented. The four zones are:

- *Territorial Sea* – Australia has sovereignty over the territorial water, the outer limit of which is 12 nautical miles seaward of the baseline. Australia has comprehensive controls in this area, except that it must respect the right of ‘innocent’ passage of foreign vessels.
- *Contiguous Zone* – the area between 12 and 24 nautical miles seaward of the baseline. Australia can take limited enforcement measures in customs, fiscal, sanitary and immigration matters in this zone.
- *Exclusive Economic Zone (EEZ)* – the area between 12 and 200 nautical miles seaward of the baselines. Australia has the right to explore and exploit living and non-living resources. It is also obliged to protect and conserve the marine environment.

-
- *Continental Shelf* – includes the EEZ and any areas of continental shelf beyond 200 nautical miles. Australia has the right to explore and exploit living and non-living resources.

An Australian Fishing Zone was declared in 1979 and is now under the *Fisheries Management Act 1991*. The zone extends from 3 to 200 nautical miles. The waters off the Australian Antarctic Territory were excepted from the AFZ in 1979 for foreign and national vessels.

3.3.5.2 Fisheries Management

The Australian Fisheries Management Authority (AFMA) manages the Northern Prawn Fishery (NPF). Two of AFMA's objectives are to: manage the sustainable exploitation of fisheries under the concept of ecologically sustainable development; and maximise the economic efficiency of fisheries. Each Commonwealth fishery provides a yearly assessment of the stocks through the Fishery Assessment Groups. The principle source of planning and advice to AFMA on the management of the NPF is the Northern Prawn Fishery Management Advisory Committee (NORMAC). Management has closed seagrass beds to trawling to protect the nursery habitats of the Northern Prawn Fishery. Other spatial and seasonal closures are also in place to ensure the sustainable exploitation of the prawn stocks, particularly tiger prawns.

Western Australia Fisheries has jurisdiction for all WA fisheries except for the Northern Prawn Fishery (the NPF includes the prawn trawling in the Joseph Bonaparte Gulf), and tuna fisheries. Fisheries are managed under a system of Management Advisory Committees. The proclamation of the *Fish Resources Management Act 1994* enabled the Department of Fisheries Western Australia to take a more pro-active role in the management of marine, estuarine and riverine ecosystems. A Fish and Fish Habitat Protection Program was established and there is also a MOU being set up between the EPA and Department of Minerals and Energy for the referral of mineral exploration and resource development proposals in the marine environment in Western Australia (Fisheries WA, 1997). A community management structure is also in place for fishing in the Kimberley (as part of the National Fisheries Action Plan) and a strategy is being developed for managing Indigenous fisheries (Fisheries WA, 1998).

As with Western Australia and Queensland, fisheries in Northern Territory are managed on a species by species basis with the Northern Prawn Fishery managed by the Commonwealth. Management advisory committees are actively involved in developing management policies for the sustainable harvest of key fish species. The development, management and conservation of fish and aquatic life in the Territory are managed under the *Fisheries Act 1988* and Fisheries Regulations (Billyard and Pyne, 1996). They provide for the management of fishery resources through management plans controlling all user groups; and the licensing of commercial fishers, traders and processors, aquaculture operators and others. The Northern Territory has 14 declared fisheries, of which the most important are the barramundi, coastal net and line fishery, and the mud-crab fishery. Fishery management areas can be declared and currently there are four marine parks/reserves in the NT. The objectives of management include: the sustainable use of aquatic resources; the preservation of aquatic species; the optimal use of areas; and the sustainable development of aquaculture.

Fisheries management in Queensland is undertaken by the Queensland Fisheries Management Authority (QFMA). Its prime function is to deliver management in keeping within the principles of ESD. The principal sources of planning and advice to the QFMA are six management advisory committees (MACs) and ten zonal advisory committees (ZACs). There is a ZAC for the Gulf of Carpentaria based in Karumba. This committee provides a source of local advice to QFMA as well as providing a role in exchanging information (QFMA Annual Report, 1997).

3.3.5.3 Marine Protected Areas

In Western Australia, the conservation of marine species occurs through the *Wildlife Conservation Act 1950*. This includes species that migrate to, or through State waters. There are three types of MPAs in Western Australia;

marine nature reserves, marine parks, and marine management areas. Marine reserves may be established under special legislation and under the *Fisheries Act*. Under the *Conservation and Land Management Act 1984*, marine nature reserves are for:

- a. conservation and restoration of the natural environment;
- b. protection, care and study of indigenous flora and fauna; and
- c. preservation of any feature of archaeological, historic or scientific interest.

Marine flora and fauna may not be ‘taken’, except for scientific purposes under license (Wilson, 1996). Recreational and commercial fishing are not permitted.

Commercial and recreational fishing are permitted in marine parks under the *Fisheries Act* administered by the Fisheries Department. Marine parks are a multiple-use category of MPA. Zoning is used to manage for restricted conservation or recreational purposes. Four categories of zones are used: sanctuary zone – complete protection of ecosystems (ie. no fishing) but with compatible recreation and tourism; recreation zone – allows boating and recreational fishing; general use – for recreation and commercial use, including fishing; and other – for any specified conservation, recreational or commercial activity consistent with the purpose of the park. A Marine Parks and Reserves Authority has been established, in which marine conservation reserves are vested. The authority is supported by a specialist scientific advisory committee.

MPAs under the jurisdiction of the Northern Territory are managed by the Parks and Wildlife Commission and the Department of Primary Industry and Fisheries (Billyard and Pyne, 1996). Both departments may be involved in the management of MPAs or only one. MPAs managed by Parks and Wildlife are established under the Territory *Parks and Wildlife Act*, the *Crown Lands Act*, or park-specific legislation. If MPAs are established under the *Parks and Wildlife Act*, management plans must be developed that encompass a range of areas eg. tourist programs/facilities, fishing, vehicle access, boating and camping. The Minister of Primary Industry and Fisheries may declare an area or fishery to be a managed area or fishery. In addition to the 14 managed fisheries, two areas have been declared for the protection of aquatic life in the Territory, both in Darwin (Billyard and Pyne, 1996). These areas have a management plan and a management advisory committee may be formed to advise the Minister.

No single agency in Queensland has a mandate for managing all marine resources (Eager and Campbell, 1996). Management across the high-water mark is complicated because most powers apply either above or below this boundary. Although the conservation of the marine environment has been achieved mainly through the marine parks, national parks and fisheries legislation, about 50 pieces of legislation on coastal management are listed in the Coastal Protection Strategy. Queensland’s *Nature Conservation Act 1992* and the Environmental Protection Bill and the Coastal Protection Bill were developed to end the fragmented approach to managing environmental issues. The most significant pieces of legislation that provide for MPAs in Queensland are: *Marine Parks Act 1982–88*, *National Parks and Wildlife Act*, *Fauna Conservation Act 1992*, *Fisheries Act 1994* and *Fishing Industry Organisation and Marketing Act*. MPAs in Queensland have also been declared under two Acts of the Commonwealth; the *Great Barrier Reef Marine Park Act 1975* and the *Historic Shipwrecks Act 1994*. Queensland is currently developing a strategy to identify adequate representative areas for their possible declaration as MPAs. The strategy is expected to be released by the end of 1999. Several studies have been undertaken in the Gulf of Carpentaria and Torres Strait to support this strategy. Queensland also has a series of ‘declared fish habitat areas’, which are specifically designed to protect critical habitats that sustain fish and invertebrates. They have been declared throughout Queensland to enhance existing and future fishing activities and protect the habitat upon which fish and other aquatic fauna depend (Beumer *et al.*, 1997).

4 Research and Development, and Natural Resource Information

4.1 Research and Development

Existing or planned research and development activities on marine and terrestrial issues in the study area are summarised in Table 16–17. It is important to note that this list is not exhaustive, and gives only those major R&D providers or programs that are **based in the study area**. Table 16 summarises the key Cooperative Research Centres with research programs in the study area or with research programs directly applicable to the subject of this scope. Table 17 concentrates on specific research proposals being undertaken within the study region. Appendix C lists those R&D projects operating outside the region or at a national level that we believe are applicable to any R&D proposals arising from this study. The tables draw on information provided in the ARRIP database <www.infoscan.com/arrip>. Most of the R&D capacity within the study area is located in Darwin, with most R&D in the region done by non-resident R&D providers. Profiles for these providers are given on the study web page <<http://irum.tag.csiro.au/nassis>>. The main R&D providers are:

- universities: James Cook University, Murdoch University, University of Queensland,
- CRCs: CRC for the Sustainable Development of Tropical Savannas, CRC for Aquaculture, CRC for Sustainable Tourism, CRC for Aboriginal Tropical Health
- government: AIMS, Agriculture WA, CSIRO, ERISS, Fisheries WA, Queensland Departments of Natural Resources and Primary Industries, NT Department of Primary Industry and Fisheries, NT Parks and Wildlife Commission, WA Conservation and Land Management
- non-government organisations: Bureau of Sugar Experiment Stations, Centre for Aboriginal Economic Policy Research, Centre for Resource and Environmental Studies, North Australia Research Unit, Centre for Indigenous Natural and Cultural Resource Management, ARC Key Centre for Tropical Wildlife Management

Much of the current R&D investment on terrestrial natural resource management and planning in the study area is focused on technical issues such as stabilising pastures, (pasture species), managing introduced legumes, controlling woody weeds, restoring pasture and some aspects of biodiversity. The scale of this work is predominantly plot or paddock. Some measurements of run-off, sediment and nutrient loss being made at this scale may help with understanding grazing management/soil erosion interactions at larger scales. Some of these projects have considerable involvement from producers, which would be useful in future R&D (Roth *et al.*, 1998).

A major initiative not listed in Table 17 is the BEEFPLAN project (currently being developed by MLA within NAP3). It uses a holistic approach to property management by building on the expertise of producer groups operating in a complex system. The objective is to use their expertise to develop management systems that enable a mix of new technologies and principles, information and opportunities to be applied to the business. It is hoped that this approach will maximise benefits from existing R&D outcomes and understanding of sustainable land management

There are various other projects under way to investigate land and water resources, their general condition and their management. Several projects either directly or indirectly examine the effects of pasture sediment and nutrient loss though none specifically examine the effects on aquatic and marine ecosystems. The multi-agency program (led by QDNR) on the effects of climate variability on pasture (grass) growth will however, collect information on overland flow and discharge.

In the Kimberley, the R&D focus has been on crop agronomy in the Ord River Irrigation Area and on grazing management and land-condition relationships. The Ord is the only catchment in the study area where an attempt has been made to source sediments and relate them to grazing management (Novelly, 1994; Wasson *et al.*, 1994). These studies offer valuable insights and data that would be useful as a benchmark for studies of long-term trends.

The Victoria River catchment has received considerable attention, both from Federal and State agencies. The former CSIRO Division of Tropical Crops and Pastures, which operated a research station in Katherine until 1994, focused on improved pastures, stocking densities and grazing ecology. The CRC for the Sustainable Development of Tropical Savannas has selected the Victoria District for a case study. CSIRO Wildlife and Ecology, currently still very active through the Tropical Ecosystems Research Centre in Darwin, has focused its research within the CRC on forms and functions of savannas along a transect from Darwin to the eastern and south-eastern part of the Victoria River. Apart from satellite-based land-condition work, most research has been on pasture management at plot to paddock scales, with very little catchment hydrology.

The main agencies undertaking marine research in the north are the Australian Institute of Marine Science, CSIRO and various universities. AIMS currently has eight major themes of research. It has a focus on ESD through its role in the CRC for the Great Barrier Reef. AIMS has been involved in research on the North-West Shelf and is currently working in the North-West Shelf region. CSIRO Marine Research has a long history of research in northern Australia, particularly in the Torres Strait, the Gulf of Carpentaria and the North-West Shelf. Initially, research focused on providing information for the management of fisheries (particularly tropical rock lobster, prawns and trawl fisheries). However, the focus has changed to include: providing information for environmental planning; assessing the impacts of trawling on benthic habitats and by-catch species; developing techniques for the rapid assessment of marine habitats and resources (experimental design, remote sensing, acoustics); developing statistical techniques for calculating confidence limits on spatial data; and developing multiple-use strategic plans for the marine environment. The Division has developed collaborations with State fisheries in Queensland, the Northern Territory and Western Australia to work on different projects.

Universities in each of the States are doing R&D relevant to the sustainable use of marine resources, but not necessarily in the study region. The relationships between marine fauna and habitats are being investigated at most universities. Research on the ecology of dugongs is being carried out at James Cook University. The impacts of eutrophication on marine plants are being investigated at several universities, particularly the University of Queensland. Work on remote sensing and GIS is also being done at the Northern Territory University, where these tools are being used in assessing the resources of trochus, trepang, turtles and crocodiles in the NT.

In each State, different agencies are responsible for research on the sustainable use of marine fisheries resources and conserving marine resources. The DEP and CALM are interested in mapping habitats in all WA's waters at a broad scale (1:100,000), and in areas of high conservation value or those under threat, at a fine scale areas (<1:10,000). They are also interested in identifying marine bioregions, particularly for the declaration of marine protected areas. NTDPIF is undertaking R&D investigating stock assessment and the distribution and movement of species fished by commercial and recreational fishers. This includes identifying critical habitats for commercial and recreational species. Current research being undertaken by NTPWC focuses on: developing broad-scale habitat mapping methods; developing procedures for the rapid assessment of resources; work on habitat mapping and rapid assessment in the Cobourge Marine Park; sustainable harvest of trepang; remote sensing of a NT bio-geographic region; and the identification of dugong and turtle feeding/breeding habitats. In Queensland, seagrasses have been monitored around Karumba and mapped from Cape York to Karumba by QDPI. Mangroves are also being mapped around the whole Queensland coast from remote sensing images at 1:100,000. The QDEH has responsibility for identifying broad biogeographic regions to assess the extent of protection for marine habitats in each region. The Department is involved in the Torres Strait Conservation Study and the mapping of wetlands.

4.1.1 Research and Development Priorities from Literature

The research needs of tropical Australia as identified from the literature are summarised in Table 18. While not exhaustive, they provide an accurate 'snapshot' of the needs and consequently of the variety of issues affecting northern resource use and management.

Table 16. Cooperative Research Centres and relevant research programs for the study region.

CRC	Relevant Objectives	Relevant Research Programs
RESIDENT		
CRC for Aquaculture	<ul style="list-style-type: none"> The Centre’s program is aimed at providing the technological basis for a sustainable industry, sustainable because it is internationally competitive and environmentally acceptable, and maintains high health standards 	<ul style="list-style-type: none"> Health protection and maintenance Nutrition and feed development Finfish propagation and broodstock management Production efficiency and environmental management Product technology
CRC for Sustainable Development of Tropical Savannas	<ul style="list-style-type: none"> To achieve sustainable use and conservation of Australia’s tropical savannas through excellence in collaborative research, communication and education 	<ul style="list-style-type: none"> North Australia landscapes Landscape processes Ecosystem management Human capability development
CRC for Sustainable Tourism	<ul style="list-style-type: none"> Businesses, products and consumers – creative, profitable tourism businesses delivering the most appropriate products to satisfied clients Tourism development contributing environmentally, economically and socially to local, regional & national communities Collaboration between stakeholders open, honest and mutually beneficial collaboration between researchers working in partnership with businesses, government and community R&D funding and resources adequately financed and resourced research programs to deliver agreed outcomes and benefits Delivering Australian services and products into an international market 	<ul style="list-style-type: none"> Tourism planning & environmental management Tourism technology, engineering & design Tourism policy, products & business systems Tourism industry extension Consulting – National Centre for Tourism Regional tourism research
NON-RESIDENT		
Australian Petroleum CRC	<ul style="list-style-type: none"> To become recognised as Australia’s premier provider of research and development to the upstream petroleum industry, of which it will be seen as an integral part To work with the Government to assist in implementing Government strategies and to marshal the disciplinary breadth across its participants and from the international network to achieve its research and commercialisation objectives 	<ul style="list-style-type: none"> Petroleum exploration technology Basin analysis Reservoir characterisation
CRC for Australian Mineral Exploration Technologies	<ul style="list-style-type: none"> To develop low-cost airborne electromagnetic (AEM) systems optimised for mineral exploration in Australia 	<ul style="list-style-type: none"> Airborne EM systems EM interpretation software Mathematical modelling Airborne EM mapping
CRC for Catchment Hydrology	<ul style="list-style-type: none"> The CRC for Catchment Hydrology exists to improve the understanding of catchment hydrology and its application to land and water management The CRC for Catchment Hydrology is a cooperative venture in public good research. The organisation represents a close collaboration between research and industry organisations 	<ul style="list-style-type: none"> Flood hydrology Salinity Waterway management
CRC for Freshwater Ecology	<ul style="list-style-type: none"> To conduct high quality research that contributes to scientific understanding of aquatic ecosystems To provide stress-response relations for a variety of natural and human-induced disturbances on aquatic ecosystems To use research findings to provide better predictive tools and strategies for those using and managing land and water resources; to work collaboratively with managers in the conduct and implementation of research To provide an avenue to international science to ensure relevant new approaches and techniques are available in Australia 	<ul style="list-style-type: none"> Ecological assessment Energy and nutrient dynamics Water regime and allocation Restoration and rehabilitation ecology

CRC	Relevant Objectives	Relevant Research Programs
CRC for Sustainable Development of the Great Barrier Reef	<ul style="list-style-type: none"> • Provide quality and timely information on land and water management to resource managers, the water industry and the Australian community to use and manage catchment and water resources on a sustainable basis • Better understanding of the present and future environmental status of the GBR and its relationship to a wide range of external and internal stresses • Improved scientific basis for decision-making on ecologically sustainable use and extraction levels for reef-based commercial and recreational activities • Improved industry scope for sustainable operations and cost competitiveness • Improved range of sustainable technologies for reef-based infrastructure, its installation and maintenance • Development of technologies for rehabilitation of reef systems following natural and human induced damage • Development and continual upgrading of accepted, scientifically based, benchmarks to improve evaluation and monitoring of reef-based activities • Improvement of scientific and management based knowledge and skills of user groups and research communities through effective information, training, education and extension services • Development of scientific information on key events to support, in collaboration with relevant management agencies, mechanisms for effective response to natural and man-made environmental events as they might occur • Application of specific measures to incorporate research outcomes into reef management, regulation, policies and practices 	<ul style="list-style-type: none"> • Regional environmental status • Operations • Engineering • Application of research, communication and extension • Education
CRC for Sustainable Sugar Production	<ul style="list-style-type: none"> • Assessment of current environmental scenarios and budgets for inputs to and losses from sugarcane production systems • Development and promotion of production practices consistent with environmental protection and ICM principles • Guidelines for dealing with unacceptable drainwaters from canelands, and use for solid wastes and sewage effluents • Technologies to minimise the problems associated with adverse soil chemical and physical properties • Use of computer-based inventories of soil, water and climatic resources to aid industry planning • Development and promotion of soil conservation practices based on conservation of crop residues • Better management of water and nutrient supply to match sugarcane needs and avoid losses to the environment. • Tools to enable better crop scheduling and yield forecasting 	<ul style="list-style-type: none"> • Environmental protection • Sustaining soil & water • Enhancing productivity • Systems analysis and modelling cross program
CRC for Tropical Pest Management	<ul style="list-style-type: none"> • Facilitate the participation of industry and scientists in project planning and monitoring • Developing generic technologies and approaches (eg. software, molecular techniques and social science) for tackling a wide range of pest management problems • Applying these technologies and approaches to specific problems across a range of agricultural industries (including insect pest problems in the field crop and horticultural industries and perennial weeds in rangelands) • Using conventional and novel communication methods, especially software, to educate, train, and provide decision support to students, farmers, crop consultants, research scientists and policy makers 	<ul style="list-style-type: none"> • Centre for identification and diagnostics • Research, development and extension connections • Centre for pest information technology and transfer • Centre for the architectural ecology of plants • Host specificity for biological control • <i>Heliothis</i> information and forecasting service
Distributed Systems Technology Centre	<ul style="list-style-type: none"> • To conduct world class research, develop software, offer training and professional consulting services, and host part of the Research Data Network CRC 	<ul style="list-style-type: none"> • Workflows, Collaborative Computing, Groupware, Notification Services, Distributed Object Middleware, CORBA, Java, Distributed Databases, Data Access • Internet Searching, Metadata, XML • Knowledge Management, • Security, Networks, Distributed System Management.

Table 17. Current R&D projects relevant to natural resource planning and management resident in the study area. NTDLPE = Northern Territory Lands Planning and Environment; NTDPIF = Northern Territory Department of Primary Industry and Fisheries; QDNR = Queensland Department of Natural Resources; QDPI = Queensland Department of Primary Industry.

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Agriculture								
Cotton	Field evaluation of Ingard cotton varieties and integrated pest management (IPM) systems in the Kimberley	1996–1999	<ul style="list-style-type: none"> To develop a preliminary integrated pest management (IPM) system for Ingard cotton grown in the Kimberley To screen available Ingard varieties for field efficacy against a range of lepidopteran pests To determine periods of Bt expression decline in Ingard varieties To assess the relative importance of potential components of an IPM system for Ingard cotton, including Envirofeast, trap crops and refugia 	Kimberley WA Fitzroy River Broome WA Cape Leveque Coast	Agriculture Western Australia	Mr GR Strickland Dr GP Fitt Ms AJ Annells	Cotton R&D Corporation Agriculture Western Australia Monsanto	\$2,907,000
	Development of management options for dry season cotton production in north-west Australia	1995–1998	<ul style="list-style-type: none"> Integrate appropriate varieties, agronomy and pest management to provide a technological package for the establishment of an irrigated dry season cotton production system in north-west Australia 	Kununurra WA Ord River Narrabri NSW Namoi River	CSIRO Plant Industry, Australian Cotton Research Institute	Dr GP Fitt Dr GA Constable Mr ST Yeates	Cotton R&D Corporation CSIRO	\$120,080
Irrigation	Effective irrigation of suitable soils on uneven surfaces	1996–1998	<ul style="list-style-type: none"> To improve the efficiency of irrigation practices on uneven surfaces having regards for furrow and trickle irrigation To analyse the most cost effective means of irrigating uneven surfaces through life cycle cost analysis To establish guidelines for best practice in selection, layout and management of irrigation systems To disseminate findings to growers through workshops and shed meetings 	Ord River WA Sugar cane areas QLD Sugar cane areas NSW Cotton areas NSW Cotton areas QLD	Bureau of Sugar Experiment Stations	Mr LG Tilley	Land and Water Resources R&D Corporation	Not Available
Sandalwood	<i>Santalum album</i> (Indian sandalwood) for the Kimberley region of Western Australia	Not available	<ul style="list-style-type: none"> To determine the best soil type, host species and planting design for <i>S. album</i> To raise clones, through in vitro propagation of superior trees in Kununurra To test the genotype environment interaction on timing and quality of oil production by growing clones in different geographic locations: Kununurra, Carnarvon and Geraldton 	Frank Wise Research Station, Kununurra, WA	Murdoch University, School of Biological and Environmental Sciences Rural Industry R&D Corporation	Assoc Prof AJ McComb	Australian Sandalwood Company WA Conservation and Land Management Agriculture WA	Not Available
Pests	Management and control of <i>Mastoterme</i> s in northern Australia	1994–1997	<ul style="list-style-type: none"> To develop effective control procedures against <i>Mastoterme</i>s in horticultural crops that are cost effective, environmentally sustainable and can be applied by growers or other personal non-expert in termite biology and control To develop methods for the study of the biology of <i>Mastoterme</i>s in natural and disturbed habitats 	Darwin and North Kimberley	CSIRO Entomology	Mr L Miller Mr S Smith Mr G Strickland	Rural Industries R&D Corporation Wildman River Plantations Pty Ltd	\$30,000

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
	Various Land Management Projects	Ongoing	<ul style="list-style-type: none"> Monitoring impacts of military use and destocking on clay grasslands and woodlands Monitoring and assessment of fire regimes and their effects on habitat for long term management Monitoring impacts of pastoralism and military use on the abundance of large mammalian predators, macropods and arboreal mammals 	North Australia defence estate	Department of Defence	Mrs K Isaacs	Department of Defence	Not Available

Environment/Biodiversity

Biodiversity	BioGraze: waterpoints and wildlife	1997–2000	<ul style="list-style-type: none"> Demonstrate how a rangeland region can be ‘designed’ to integrate biodiversity conservation and pastoral activities Quantify the extent of decline of biodiversity at regional scales, and explore management strategies within the context of continued pastoral landuse, which target species most vulnerable to grazing and other disturbances associated with artificial sources of water Estimate the economic cost of these strategies in exemplary region 	Central Australia	CSIRO Wildlife and Ecology SA Department of Environment and Natural Resources Parks and Wildlife Commission of the Northern Territory	Dr CD James Dr J Landsberg Mr R Tynan Dr A Fisher	Land & Water Resources R&D Corporation Environmental Australia	\$560,000
Fire	Effect of time of burning on <i>Atalaya hemiglauca</i> (whitewood) and its understorey	Not available	<ul style="list-style-type: none"> To assess the effect of fire on whitewood growth and development To assess the effect of time of burning on whitewood control To assess the effect of time of burning on the herbaceous understorey 	Not Available	Agriculture Western Australia	Dr P Novelty	Agriculture WA	Not Available
	Fire Management in North Australia	1998–2001	<ul style="list-style-type: none"> Fire Management in North Australia 	Cape York, Arnhem Land, Kimberley	NT Bushfires Council,	Jeremy Russel-Smith	Natural Heritage Trust	Not Available
Salinity	Paddock scale guidelines for salinity management	1997–1998	<ul style="list-style-type: none"> Integrating point and catchment scale models to develop vegetation management strategies which will minimise salinity risk in the Balfes Creek catchment 	Balfes Creek, Burdekin Catchment	CSIRO Land & Water Queensland Department of Primary Industry	Ian Gordon Dr C Roth	Land & Water Resources R&D Corporation	\$107,500
Water	Water table monitoring in the Ord River Valley	1995–1999	<ul style="list-style-type: none"> Examine the significance of rising groundwater in the Ord River Irrigation Area, and identify requirements for efficient water management and sustainable production for the Ord cane industry. 	Kununurra	Agriculture WA	Dr JH Sherrard	Sugar R&D Corporation	\$9,600
	Examination of ecologically sustainable groundwater pumping rate	1996–1998	<ul style="list-style-type: none"> Quantify the recharge and discharge rates of groundwater in a tropical savanna catchment Estimate dependence of vegetation on groundwater Estimate possible vegetation changes in response to groundwater changes Assess the applicability of this approach to other catchments 	Not Available	CRC for Sustainable Development of Tropical Savannas CSIRO Land and Water	Dr D Eamus Dr PG Cook Mr L Hutley	Land & Water Resources R&D Corporation	\$150,472
	Estimation of sustainable groundwater pumping rates	1996–1998	<ul style="list-style-type: none"> Water balance including groundwater recharge 	Near Darwin	Northern Territory Department of Primary Industry and Fisheries	Derek Eamus	Land & Water Resources R&D Corporation	\$150,472

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Fisheries/Marine								
Assessment	Tropical resource assessment program: development of models describing stock dynamics and exploitation in north Queensland fisheries	1995–2000	<ul style="list-style-type: none"> Provide management input in the form of options to achieve sustainable levels of harvest, desirable species mix in the harvest, and allocation of resources 	Not Available	Queensland Department of Primary Industries QDNR; CSIRO Tropical Agriculture	Dr N Gribble	Fisheries R&D Corporation	Not Available
	Troll Fishery for Spanish Mackerel	Not available	<ul style="list-style-type: none"> Identify the sectors of the fishing industry exploiting mackerel, their target species, and fishing unit characteristics 	Darwin	Northern Territory Department of Primary Industry and Fisheries	R Buckworth, N Gill, C Bryce	Not Available	Not Available
	Mary River Wetlands Project	Not available	<ul style="list-style-type: none"> Locate, characterise and map barramundi nursery habitat areas in the coastal zone adjacent to Chambers Bay and Finke Bay 	Darwin/Coastal areas from Cape Hotham to Wildman River	Northern Territory Department of Primary Industry and Fisheries	R Griffin, G White, P Johnson	Fisheries R&D Corporation	Not Available
Management	The effects of net fishing: addressing biodiversity and bycatch issues in Queensland inshore waters	1997–2000	<ul style="list-style-type: none"> Establish proportions of target catch and bycatch caught in inshore net fisheries along the Queensland east coast and Gulf of Carpentaria Characterise bycatch in terms of species composition, seasonal abundance, habitat type and mesh size Determine the fate of fish discarded from net catches Establish the effects of net fishing on biodiversity Provide management advice on sustainability and biodiversity indicators, and changes in net fishing practices to reduce bycatch. 	Queensland east coast Gulf of Carpentaria	Queensland Department of Primary Industries Australian Institute of Marine Science	Mr I Halliday Mr RN Garrett Dr JA Ley	Fisheries R&D Corporation Queensland Department of Primary Industries Australian Institute of Marine Science	\$2,114,548
	The impacts of ponded pastures on barramundi and other finfish populations in tropical coastal wetlands	Not available	<ul style="list-style-type: none"> Assess movement, growth and survival of barramundi in ponded pastures Assess the utilisation by barramundi of ponded pastures and wetlands dominated by exotic grass species Identify appropriate wetland management strategies for facilitating barramundi movement and survival in ponded pastures Document fish bycatch and their relevant abundance in ponded pastures. 	Queensland	Queensland Department of Primary Industries Northern Territory Department of Primary Industries and Fisheries QDEH	Mr SJ Hyland	Fisheries R&D Corporation	\$222,056
Pearl	Growth of pearl oysters in the southern and northern areas of the pearl oyster fishery and examination of environmental influences on recruitment to the pearl oyster stock	1995–1998	<ul style="list-style-type: none"> To determine growth rates of pearl oysters in the Lacepede Channel and Exmouth Gulf areas To utilise the existing and new knowledge of time lags between spatfall and recruitment to the fishery, and the period of vulnerability to fishing, to carry out analyses of possible environmental influences on recruitment. 	Lacepede Channel WA Exmouth Gulf WA	Western Australian Fisheries Department, Research Division	Dr LM Joll	Fisheries Research and Development Corporation	\$143,491

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Prawn	Risk analysis and sustainability indicators for prawn stocks in the Northern Prawn Fishery	1998–2000	<ul style="list-style-type: none"> Assess the probability that current Northern Prawn Fisher prawn stocks are being fished at sustainable levels (as defined by NORMAC) by carrying out a risk analysis Predict the performance of future NPF management alternatives by comparing predicted stock parameters against NORMAC performance indicators of stock status 	North Australia	CSIRO Marine Research	Dr D Die	Fisheries R&D Corporation	Not Available
	The definition of effective spawning stocks of commercial tiger prawns in the NPF and king prawns in the eastern king prawn fishery—behaviour of post-larval prawns	1997–2000	<ul style="list-style-type: none"> To measure the critical vertical migration behaviour of postlarval tiger and king prawns that determines their inshore advection patterns To incorporate this behaviour into hydrodynamic models to accurately estimate the effective spawning stocks of tiger and king prawns 	Embley Gulf, Weipa, Gulf of Carpentaria	CSIRO Division of Marine Research	DJ Vance	Fisheries R&D Corporation	Not Available
Stock Assessment	Stock Structure of Goldband Snapper Resources Across Northern Australia	1996–1998	<ul style="list-style-type: none"> Investigate the stock structure of goldband snapper (<i>Pristipomoides multidens</i>) in northern Australian waters, to assist in the development of appropriate management plans for the deepwater snapper fisheries of Northern Territory and Western Australia 	Northern Territory and Western Australia	Northern Territory Department of Primary Industry and Fisheries Western Australian Fisheries Department	J Lloyd	Fisheries R&D Corporation	Not Available
	Stock assessment of the outer shelf species in the Kimberley region of tropical WA	1997–2000	<ul style="list-style-type: none"> To estimate essential population parameters of goldband snapper and other key demersal species To advise fishery managers and industry on the combinations of gear and effort controls to produce optimal sustainable yields 	Kimberley	WA Fisheries Department	Dr M Moran	Fisheries R&D Corporation	Not Available
	The Kimberley Demersal Fishery: extent and nature of the resource and the ability of a trap fishery to exploit it	Not available	<ul style="list-style-type: none"> To determine the extent and nature of the Kimberley Demersal Fishery To determine the ability of a trap fishery to exploit these resources 	Kimberley	Western Australian Fisheries Department	Dr J Penn	Fisheries R&D Corporation Australian Fisheries Management Authority	Not Available
Stock Allocation	Research for allocation of north-west marine finfish stocks among diverse user groups	Not available	<ul style="list-style-type: none"> To estimate the degree of overlap in resource use among the diverse commercial and recreational user groups of the north-west marine finfish stocks To relate the degree of damage sustained by the habitat to the level of trawling and trapping effort, using standard and low-impact gear To investigate the distribution of juveniles of major species, and the vulnerability to the various gear types 	Kimberley	Western Australian Fisheries Department, Marine Research Laboratories	Dr M Moran	Fisheries R&D Corporation Australian Fisheries Management Authority	Not Available

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Trawling	Effects of trawling: ecological sustainability of bycatch and biodiversity in prawn trawl fisheries	1996–1999	<ul style="list-style-type: none"> Develop cost effective, accurate and feasible methods of describing and monitoring prawn trawl bycatch acceptable to all stakeholders Compile a detailed description of the bycatch in the Northern Prawn Fishery and Torres Strait tiger and banana prawn fisheries, and Queensland east coast banana prawn fisheries Measure the impact of prawn trawling on the sustainability of important vertebrate bycatch species, particularly vulnerable or endangered species, and those bycatch species where no significant reductions can be achieved Assess the effects of prawn trawling on the biodiversity of key fish and other vertebrate communities 	Gulf of Carpentaria Torres Strait	QDPI University of Tasmania	Dr S Blaber Mr M Dredge Dr CD Buxton	Fisheries R&D Corporation	Not Available
Trochus	Reef re-seeding research of the topshell, <i>Trochus niloticus</i> in northern Australia, eastern Indonesia and the Pacific	1995–NFD	<ul style="list-style-type: none"> To establish the feasibility of maintaining sustainable trochus fisheries in northern Australia, eastern Indonesia and Vanuatu through reseedling with hatchery produced juveniles To transfer production hatchery technology developed at the Northern Territory University to participating institutions. This involves training and establishing pilot hatcheries in each country To develop strategies for seeding juveniles on selected coral reefs 	Northern Australia Vanuatu	Australian Centre for International Agricultural Research	Mr B Smith	Australian Centre for International Agricultural Research	\$692,638

Human and Social Services

	Culture, nature and environmental management in Central Australian rangelands	1996–1999	<ul style="list-style-type: none"> Analyse response of diverse rangelands users and managers to changing rangelands evaluations Evaluate the implications of these responses for the achievement of ecologically sustainable use of rangelands Develop a framework/process whereby the expectations and values of users can be incorporated into regional planning To develop and use methodologies for reflexive and responsive social research in the rangelands 	Not Available	University of New South Wales University College, Australian Defence Force Academy, Department of Geography and Oceanography	Dr K Anderson Mr N Gill	Land & Water Resources R&D Corporation	\$75,000
--	---	-----------	--	---------------	---	----------------------------	--	----------

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Indigenous								
	Participatory rural appraisal and planning: innovative methods of working with Aboriginal land managers	1996–NFD	<ul style="list-style-type: none"> To develop, with Aboriginal landowners, approaches and methods that facilitate active Aboriginal participation in describing and evaluating natural resources, which are suited to planning for ecological sustainability in the central Australian region To develop, describe and contribute to participatory processes of working with Aboriginal people that integrate nature resource assessment with other phases of land use planning To adapt and development participatory rural appraisal methods to map, describe, evaluate and document cultural and ecological features of Aboriginal land and its resources To adapt and develop participatory rural planning methods to produce plans for integrated, multi-land use systems 	<p>Central Australia</p> <p>Karantijpa Aboriginal Land Trust Area NT</p> <p>Loves Creek NT</p>	Central Land Council, Land Assessment Unit	Ms FJ Walshau	<p>Land and Water Resources R&D Corporation</p> <p>National Landcare Program</p> <p>Central Land Council</p>	<p>\$593,287</p> <p>\$73,000</p> <p>\$223,024</p>
Inter - Sectoral								
	Evaluation of integrated catchment management in a wet tropical catchment	1994–1999	<ul style="list-style-type: none"> Monitor and document the implementation of Integrated Catchment Management in the Herbert River catchment and identify the social, economic, and institutional factors that facilitate or hinder this process Evaluate key impacts of the implementation in terms of attitude and behaviour changes and changes in the severity or tractability of resource use conflicts for the catchment Assess the technical and related information needs relevant to effective ICM implementation in a wet tropical environment Develop a framework and methods for evaluation to facilitate development of effective catchment management in Australia 	North Queensland	CSIRO Tropical Agriculture	Mrs JA Bellamy	<p>Land & Water Resources R&D Corporation</p> <p>CSIRO Tropical Agriculture</p> <p>CSIRO Land & Water/CSR Ltd/ Griffith University/ Queensland Department of Primary Industries</p>	\$1,514,624
	Sustainable development of tropical Australia: research and development for management of land, water and marine resources	1998–1998	<ul style="list-style-type: none"> Identify stakeholder natural resources priority issues and determine management priorities, research and development needs, and institutional and organisational capacity Identify and review existing natural resource management data Examine and review opportunities for R&D to underpin improved natural resource management and identify potential obstacles and risks to research and development in natural resource management Specify research and development priorities to underpin improved natural resource management and options for implementation 	North Australia	<p>CSIRO Marine Research</p> <p>CSIRO Tropical Agriculture</p>	<p>Dr I Poiner</p> <p>Dr A Johnson</p>	<p>Land & Water Resources R&D Corporation</p> <p>Fisheries R&D Corporation</p>	\$50,000

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
	The determinants of land degradation in wet/dry tropical savannas	1993–1998	<ul style="list-style-type: none"> Define the relationships between soil type, mean annual rainfall and the vegetation communities in the wet/dry tropical savannas of north-western Australia, using existing GIS data Develop an improved understanding of the processes of land degradation in the wet/dry savannas, and formulate a rating of soil/rainfall/vegetation associations based on risk of degradation 	Northern Territory	CSIRO Wildlife and Ecology	Dr GD Cook Dr D Williams	Land & Water Resources R&D Corporation Conservation Commission of the Northern Territory	\$431,737
	Land use in northern Australia: impact of markets, policy and climate change	1996–1998	<ul style="list-style-type: none"> To identify the likely impacts of various market, policy and climate change scenarios (prices, policy and productivity) on northern Australian grazing industries and provide guidelines for adaptation by managers and policy makers by analysing the sustainable profitability of enterprises under different management strategies in different regions to examine and report on the effectiveness of different management strategies in coping with these changes, and extend these results through LWRDC Project CWE8 network ('DroughtPlan') 	Northern Australia	CSIRO Wildlife and Ecology, National Rangelands Program Queensland Department of Primary Industries	Dr M Stafford Smith Dr G McKeon	Rural Industries Research and Development Corporation Department of Environment, Sports and Territories	Not Available

Pastoral

Camels	Co-grazing of cattle and camels for commercial production	1997–2001	<ul style="list-style-type: none"> To obtain objective production data on co-grazing cattle and camels compared to grazing cattle only To improve knowledge of the impact of camels on native vegetation in Central Australia To improve knowledge of the impact of camels on woody weed species in Central Australia To obtain objective data on pasture utilisation by co-grazing cattle and camels, compared to grazing cattle only To demonstrate the potential for co-grazing two species with different dietary preferences to improve productivity and income stability 	'Waite River' Station, via Alice Springs NT	Northern Territory Department of Primary Industries and Fisheries Northern Territory Parks and Wildlife Commission	Mr AJ Phillips Dr B Dorges Dr JF Heucke Mr IA White	Rural Industries Research and Development Corporation Northern Territory Department of Primary Industries and Fisheries	\$240,520
Carrying Capacity	Development of carrying capacity estimates for varying range condition in East Kimberley	1991–NFD	<ul style="list-style-type: none"> To determine carrying capacities over a range of condition classes for East Kimberley land systems and pasture types 	East Kimberley, WA	Agriculture Western Australia	Dr P E Novelty	Agriculture WA	Not Available
	West Kimberley exclosures	1969–NFD	<ul style="list-style-type: none"> To assess the effect of removing cattle from a range of pasture types To demonstrate to the cattle industry the effect that grazing can have on pastures 	Fitzroy Valley, West Kimberley, WA	Agriculture Western Australia	Mr JG Morrissey	Agriculture WA	Not Available

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Grazing Systems	Grazing pressure effects on herd productivity and pasture condition in north Queensland	1993–1999	<ul style="list-style-type: none"> To have 20% of the degradation prone grazing land in northern Australia operating by the year 2000 under sustainable and commercially viable land use production systems Evaluate and demonstrate that profitability and sustainability can be improved by using a conservative stocking rate in combination with key cattle management practices 	Etheridge Shire Dalrymple Shire Bowen Shire	Not Available	Mr D Smith	Not Available	Not Available
	Coordinated pasture evaluation in northern Australia	1986–1999	<ul style="list-style-type: none"> Help ensure the survival of grazing industries by planning for essential future plant evaluation work in northern Australia. 	Not Available	Queensland Department of Primary Industries	Mr IB Staples	Meat and Livestock Australia	Not Available
	Effect of slope, plant cover and rainfall intensity on run-off from red soils	1990–NFD	<ul style="list-style-type: none"> To determine the effect of soil cover, slope and rainfall intensity on run-off To determine the threshold level of residual plant cover for sustainable grazing systems 	Ord River Regeneration Research Station	Agriculture Western Australia	Dr P Novelty	Agriculture WA	Not Available

Tourism

	Tourism and environment in Central Australia: perceptions of change	Not available	<ul style="list-style-type: none"> Measure environmental impacts and perceptions of impact by tourists, operators and environmentalists Develop methods for efficiently monitoring impacts by operators 	Central NT	CSIRO Wildlife and Ecology Central Australian Regional Tourism Association, NT Tourism commission, NT Parks and Wildlife Commission	Dr G Griffin	Not Available	Not Available
--	---	---------------	---	------------	---	--------------	---------------	---------------

Table 18. Research and development priorities for northern Australia identified from the research literature.

SECTOR	RESEARCH AND DEVELOPMENT RECOMMENDATIONS	FOCUS	REFERENCE
Agriculture	Develop sustainable, irrigated tropical agriculture, particularly for sugarcane	Technical	SRDC (1997),
	Quantify key determinants of sediment, nutrient and overland flows at various scales; model to enable extrapolation to other catchments in northern Australia.	Technical	Hook (1998), Roth <i>et al.</i> (1998)
	Develop and evaluate more efficient and equitable allocation and pricing of water resources in irrigation areas	Institutional/Technical	IC (1997), Gill (1996), Johnson <i>et al.</i> (1998)
	Develop ecological indicators for tropical agricultural production systems	Technical	Walker and Reuter (1996)
	Develop effective monitoring programs for soil health, sediment, nutrient and chemical exports in the tropics	Technical	Chudleigh <i>et al.</i> (1997), Roth <i>et al.</i> (1998)
	Design and evaluate more effective and robust property rights systems, particularly for water	Institutional/Technical	Johnson <i>et al.</i> (1998), Gill (1996)
Biodiversity and Conservation	Establish a comprehensive and integrated approach to achieve sustainable land management	Institutional	IC (1997)
	Develop bioregional conservation strategies to restore and protect the distribution of native species throughout rangelands; to conserve of other natural landscape values	Technical	ANZECC and ARMCANZ (1996)
	Determine the effects of land use and disturbance on the conservation and functioning of different ecosystems	Technical	McIntyre and McIvor (1998)
	Establish the minimum environmental flow regime for northern river systems in order to maximise the environmental health of the river system	Technical	IC (1997)
	Assess the impact of grazing pressure on riparian environments in different land systems, including temporal/seasonal variation, and the sustainable level of riparian zone grazing	Technical	Hook (1998)
	Estimate the effects of exotic species, including pasture species, on different ecosystems, particularly rangelands and wetlands	Technical	McIntyre and McIvor (1998), Hook (1998), Finlayson <i>et al.</i> (1997)
	Find out the competing values and resource management needs throughout Cape York Peninsula	Technical/Capacity	CYRAG (1997)
Identify key indicators of ecosystem health in rangelands and appropriate scales to study them	Technical	McIntyre and McIvor (1998)	
Government	Develop institutional arrangements and conditions that facilitate stakeholders negotiations on regional aspects of resource management	Capacity/Institutional	Dale and Bellamy (1998)
	Design mechanisms to link resource-use planning at multiple scales and developing complementarity between different planning scales	Institutional	Dale and Bellamy (1998)
	Integrate land-use and land-management planning	Institutional	McLeod <i>et al.</i> (1997), Industry Commission (1997)
	Develop an integrated 'whole of community', stakeholder-driven process for formulating and evaluating regional development policy	Institutional/Capacity	DCT (1998), OND (1993)
	Establishment trials to progressing the development of 'whole of government' approaches to regional planning and service delivery	Institutional/Technical	Kelty (1993a)
	Research the effects of promulgating single Acts to promote sustainable agricultural resource management	Technical/Institutional	McLeod <i>et al.</i> (1997), IC (1997)

SECTOR	RESEARCH AND DEVELOPMENT RECOMMENDATIONS	FOCUS	REFERENCE
Fisheries	Continue 'basic strategic marine research' while developing applied research	Institutional	MAGOP 1998
	Find ways of incorporating fisheries issues in land-use planning, and incorporating understanding of marine and coastal processes in statutory planning	Institutional/Technical	AC (1997), WGA (1994), Cappel <i>et al.</i> (1998)
	Develop environmental standards and controls for aquaculture, particularly assessment of potential risk of disease and genetic manipulation, and understanding of the assimilative capacity of natural resource systems	Technical	MSTPWG (1998), SCFA (1998), AC (1997), FWA/KDC (1996), WGA (1994)
	Develop technologies to support sustainable aquaculture	Technical	AC (1997), WGA (1994)
	Evaluate alternative species and fisheries management scenarios from biophysical and social perspectives	Technical	SCFA (1998), Zann (1995,96)
	Evaluate use of fisheries refuges to achieve sustainability objectives	Technical	SCFA (1998)
	Evaluate multiple-use management strategies, including protected areas and zoning, in relation to fisheries and habitat improvement	Technical	SCFA (1998), Cappel <i>et al.</i> (1998), Zann (1995,96)
	Identify regional management units, using habitats, communities and ecosystems	Technical	SCFA (1998)
	Identify critical habitats for specific fisheries in freshwater, estuaries and bays, and the threats to those habitats	Technical	SCFA (1998), Cappel <i>et al.</i> (1998), Zann (1995,96)
	Improve aquaculture-site selection, taking into account off-site impacts and social and economic issues	Technical	SCFA (1998)
	Improve understanding of the role of oceans in Australia's climate	Technical	MSTPWG (1998)
	Improve monitoring procedures for Australia's marine environment	Technical	MSTPWG (1998)
	Develop Aboriginal and Torres Strait Islander fisheries strategies	Technical/Capacity	Smyth (1997)
	Determine the extent and magnitude of terrestrial impacts on the marine environment, particularly the impact of anthropogenic activities on system function; and subsequent management responses	Technical/Institutional	Cappel <i>et al.</i> (1998), Hook (1998), SCFA (1998)
Examine recreational and sport-fishing management; evaluate socio-economic values of different uses of physical and biological resources	Technical/Institutional	MAGOP (1998), SCFA (1998)	
Pastoral	Develop ways of reducing degradation of grazing land, particularly after drought, and improving recognition of grazing as a component of land degradation	Technical	Hook (1998)
	Develop farm-scale monitoring programs to help farm management, including evaluation of existing programs and information needs of land users	Technical	Hook (1998)
	Examine potential long term impacts, including economic impacts, of ponded pastures; assess the possibility and potential long term impacts of weed introduction	Technical	Hook (1998)
	Study impacts of grazing management (eg. stocking densities, spelling, fire management, fencing and waterpoint locations, tree clearing, pasture remediation) on sediment generation and nutrient loss at scales ranging from hill-slope to catchment	Technical	Roth <i>et al.</i> (1998)
	Investigate processes involved in loss of infiltration capacity of land types under different grazing regimes on different soil and vegetation	Technical	Hook (1998)
	Develop tools and frameworks to evaluate, analyse and support trade-offs between competing resource uses arising from existing R & D programs	Technical/Capacity	Hook (1998), Dale and Bellamy (1998)
Human and Social Services	Define and document the cultural, heritage and social values of the rangelands, and ensure that these values are protected in strategic planning	Technical	ANZECC and ARMCANZ (1996)
	Develop tools and techniques to assess social needs and deliver services through: service planning and impact assessment benchmarking, better links between human services provision, and land-use planning and impact assessment; improved service delivery models for communities under social and economic stress	Technical	Jones and Thornewaite (1994) in Dale and Bellamy (1998)
	Improve understanding of socio-economic processes operating in rangelands areas through better understanding of perception, needs and expectations; communications; the effectiveness of extension; links between regions	Technical	Holmes (1996a,b), Winter and Williams (1996)
	Develop technologies for remote communities	Technical/Capacity	ASTEC (1993)

SECTOR	RESEARCH AND DEVELOPMENT RECOMMENDATIONS	FOCUS	REFERENCE
	Method of incorporating the expertise of Indigenous communities into natural resource management and integration of cultural heritage in regional planning	Capacity/Technical	Dale and Bellamy (1998), CYRAG (1997), Altman <i>et al.</i> (1995), Bird (1996), Rose (1995)
	Development of arrangements for recognising and applying Aboriginal resource management and resource rights irrespective of land tenure	Institutional	Young <i>et al.</i> (1991)
	Research needs identified by Aboriginal peoples (eg. in land management, health, social services and education) given a high priority for R&D funding	Institutional	ASTEC (1993)
	Examination of subsistence resources, their current levels of utilisation, possible levels of sustainable use	Technical	Altman <i>et al.</i> (1995)
	Examine opportunities to develop production systems that incorporate wildlife use for both subsistence and economic development without limiting other economic development opportunities/avenues	Technical	CYRAG (1997), Langton (1998), Altman <i>et al.</i> (1995), Sullivan (1995)
	The extent of degradation of Aboriginal land, including erosion and compaction, weeds, feral animals and loss of biodiversity	Technical	Young <i>et al.</i> (1991)
	Guidelines for environmentally and culturally sustainable practices for Aboriginal tourism activities	Technical/Institutional	CINCRM (1997)
	Quantitative and qualitative assessment of the relative efficiency of allocating development resources to 'outstations' as opposed to centralised communities	Technical/Institutional	Sullivan (1995)
Research and Development	Examination of mechanisms to realise the opportunities for R & D in expanding agriculture, horticulture, regional tourism, water management, energy supplies and energy technologies	Capacity/Institutional	ASTEC (1993)
	Development of better links between well-defined community, business or national needs and arrangements for R & D in tropical Australia	Institutional	MAGOP (1998), ASTEC (1993)
	Development of an R & D plan for the ecologically sustainable use of rangelands and a nation-wide commitment to continuous monitoring program	Institutional/Technical	ANZECC/ARMCANZ (1996)
	Development of methods for increased public participation in R & D	Institutional/Technical	MAGOP (1998), Gill (1996)
	Refocus R&D from descriptive and data capture studies toward developing methods to predict the biophysical impacts of policy and development decisions	Technical	Clements (1996)
	Before more resources are invested, R & D in rangelands needs to develop rigorous evaluative processes for past and current R & D activity, as well as for future R & D	Technical	Dale and Bellamy (1998), Hook (1998)
	Development of improved ways of evaluating environmental goods and services	Technical	Gill (1996)
	Develop regional scale sustainability indicators that reflect biophysical and management criteria, and are linked to evaluation of resource use options	Technical	Dale and Bellamy (1998)
	Development of information technology tools to facilitate collaborative approaches to learning for integrated and adaptive resource management	Technical/Institutional	Dale and Bellamy (1998)
	Development of processes to manage disturbed environments	Technical/Capacity	Gill (1996)
	Development of improved mechanisms for stakeholders to identify and express their values	Technical/Capacity	Morton and Price (1994)

SECTOR	RESEARCH AND DEVELOPMENT RECOMMENDATIONS	FOCUS	REFERENCE
Minerals and Energy	Joint government/industry research into sustainable development of marine mining	Technical/Institutional	MAGOP (1998)
	Investigate ability of mining communities to sustain diversified economies	Technical/Capacity	O'Faircheallaigh (1991)
	Policy analysis of the institutional factors that influence mining's contribution to the social and economic development of regional Australia	Institutional	O'Faircheallaigh (1991)
	Research downstream processing of minerals products	Technical	KDC (1996)
Transport and Infrastructure	Investigate opportunities for fishing vessels to use Kimberley Ports	Technical	KDC (1996)
	Develop regionally integrated, ecologically sustainable infrastructure in regional WA	Technical/Institutional	DCT (1998)
Tourism	Develop rigorous national guidelines for eco-tourism including, monitoring of environmental impacts	Technical	DTSBI (1997)
	Market research into Aboriginal Tourism ventures	Technical	ATSIC & ONT (1997)
Inter-Sectoral	Develop GIS to support land-use planning	Technical/Capacity	KDC (1997), Moffatt (1990)
	Identify best-practice resources management	Technical/Capacity	KPG (1997), ANZECC and ARMCANZ (1996)
	Development of improved tools to model negotiation processes	Technical/Capacity	Dorcey (1986)
	Exploring non-Eurocentric models of negotiation for resource use	Capacity/Institutional	Craig (1991)
	Priority for R & D that evaluates current processes, and maximises adaptive planning and management	Institutional	Dale and Bellamy (1998)
	Possibilities for integrating qualitative and quantitative research methods and disciplines, alternative knowledge systems, and issues that arise at the discipline/knowledge interface	Institutional	McIntyre and McIvor (1998), Ludwig <i>et al.</i> (1997)
	Environmental approval processes include land-use capability assessments accredited by the Commonwealth Government; and that land use assessments identify national environmental interests	Institutional/Technical	Kelty (1993a)
	Continued improvement of the terrestrial, estuarine and marine information base, and research into links between system components, particularly management	Technical	McIntyre and McIvor (1998), ANZECC and ARMCANZ (1996), Winter and Williams (1996), ASTEC (1993)
	Development of methods of interpreting land system or unit data to assess variability in landscape productivity and susceptibility to degradation	Technical	Hook (1998)
	Economic assessment methods focused on regional sectoral viability, resource evaluation, and applicability across spatial and temporal scales	Technical	Dale and Bellamy (1998)
	Inventory and evaluation of current and previous land system and resource surveys of northern Australia	Technical	Hook (1998)
	Development of effective tools and frameworks that integrate environmental, economic and social assessment methods to analyse and support resource-use trade-offs in multiple-objective, multiple-use, and multiple-stakeholder contexts	Technical	Dale and Bellamy (1998), Hook (1998), Ludwig <i>et al.</i> (1997), CYRAG (1997), Winter and Williams (1996), ANZECC and ARMCANZ (1996)
	Development of methods and structures (eg. collaborative work spaces on WWW) that facilitate cross-fertilisation of research outcomes and methods	Technical/Capacity	Gray (1996)
	Better understanding of land-use thresholds of emerging land-management problems	Technical/Institutional	McIntyre and McIvor (1998), Ludwig <i>et al.</i> (1998)

4.2 Natural Resource Information

In this section, we summarise existing resource information, its sources and its general relevance to natural resource planning and management in the study area. Detailed inventories are provided on the scoping study's web page (<http://irum.tag.csiro.au/nassis>).

4.2.1 Terrestrial

There is a great deal of land-resource information on tropical Australia. Much of it is appropriate to management and planning at sub-catchment to large catchment scales. Depending on the date of surveys, the information may be available in digital or hardcopy format, with or without accompanying reports or documentation. While geological, topographical, land tenure and land-use information and digital elevation data are available at scales of 1:250,000 for most of the study region, extensive areas remain unmapped at scales suitable for planning and resource management. In addition, there are too few hydrological and ecological data on the main river systems in tropical Australia. Many have not been fully gauged, monitored or sampled. There are too few rainfall gauges across the region and hence modelling catchment hydrology will be constrained by insufficient temporal and spatial resolution of rainfall data and climate data in general (Roth *et al.*, 1998).

Available land-resource surveys vary in the scale of mapping, the data collected, and collection methods (Roth *et al.*, 1998). Some organisations have taken essentially scientific, often process-oriented approaches with broad relevance, while others (mainly in Queensland) have increasingly taken more specific, industry- and extension-oriented approaches. In WA, NT and Queensland, the scale of mapped land-resource data has often been small, especially CSIRO land systems surveys: generally in the range of 1:500,000 to 1:2,000,000. Only relatively small areas have been mapped at scales having greater management relevance (eg. Katherine and Ord River Irrigation Area). A common complaint is that in land-system surveys, land units are identified and described, but not located and delineated, which is a problem for land managers. In Queensland, all areas mapped as land systems are available in digital format with associated descriptions and reports. Detailed site descriptions and analytical data are also available. Thus, the terrestrial resource information available is patchy at best. Some biophysical data (geology, digital elevation data, vegetation and land cover from satellite imagery) are readily available and highly valuable for catchment-scale research. Other crucial land-resource information, in particular soil maps and information on spatial distribution of soil chemical and physical data, is patchy in some areas and of varying scale and quality. With the exception of very few extensive areas in coastal and near-coastal areas, there is virtually no soil information available at scales relevant to land-management planning or decision-making (ie. 1:50,000 for smaller properties to 1:100,000 for larger properties). This situation is unlikely to change in the short term, and certainly cannot be resolved by traditional soil and land-resource assessments. Rather, we need to develop new ways of extracting larger-scale information from existing natural-resource information, using enhanced satellite images coupled to digital terrain analysis and conceptual modelling from experienced resource surveyors and supported by strategic ground-truthing.

The North Australia Research Unit, the Centre for Aboriginal Economic Policy Research, and the Australian Institute for Aboriginal and Torres Strait Islander Studies have undertaken a substantial body of social research in the north. However, apart from the Australian Bureau of Statistics, it is largely focused on specific issues or in response to specific developments, or is uncoordinated with other studies (ASTECC, 1993). Additionally, there have been specific regional research programs, largely revolving around the impacts of resource development on Aboriginal communities: the project to monitor the Social Impact of Uranium Mining, the East Kimberley Impact Assessment Project, the Resource Assessment Commission's Kakadu Conservation Zone Inquiry, and the Coastal Zone Inquiry.

4.2.1.1 Northern Territory

The adequacy of land-resource survey data on the Northern Territory was assessed by Barson *et al.* (1997). They reported that the Territory is covered by surveys undertaken at 1:250,000, or smaller, and that most of these give general descriptions of soils, sometimes with profile descriptions; there are few quantitative point-source soil and vegetation data. The Top End of the Territory is better served. Most of the surveys established the general nature of the land resource and its broad suitability for the main forms of land use. However, information at a scale sufficient to identify specific pastoral-land management requirements and to establish whether land use is sustainable is limited. Furthermore, coverage is limited to the north and the south of the Territory: around the Top End and in the Alice Springs district. Coverage generally has been purposeful, systematic, and with a view to pre-empting requests from pastoral, mining, national park and Aboriginal interests. Currently, mapping of land resources at a scale of 1:100,000 in the Victoria River district is nearing completion.

The Northern Australian Region Geographic Information System, soon to be transferred to the Science Faculty of the NTU, holds much of this information in digital format. Its conference proceedings (1993, 1995, and 1997) list additional resource information.

4.2.1.2 Western Australia

Most attention in this State has been paid to southern regions and the adjacent northern and western crop and mining lands. CSIRO has in the past focused on the Kimberley region with land systems reports and maps of the Ord–Victoria region, the North Kimberley and the West Kimberley, but map scales have been very small, eg. 1:1,000,000 for the Ord–Victoria survey. Land-resource surveys in WA tend to be needs-driven. The WA Department of Agriculture has recently worked in more detail in the West Kimberley area, and in the Pilbara (Roth *et al.*, 1998).

4.2.1.3 Queensland

Queensland has had a concerted program of land-resource surveys. CSIRO has undertaken two large surveys (Mitchell–Normanby; Leichhardt Gilbert areas), and QDPI (now QDNR) has undertaken similar, and also more detailed, studies of the land. All semi-arid, arid and coastal areas have been mapped. The coverage is of different types, with land-system surveys declining in favour of land-resource surveys at 1:50,000–1:25,000 to meet industry and environmental requirements. The main surveys are now in digital format and are listed on the Web, except for surveys in the Cape York Peninsula area and the Soil Fertility of the Central and North East Grazing Lands study.

4.2.2 Marine

Data sets in the marine environment are diverse and widespread over many organisations. Possibly the most complete data sets are the log book data for commercially fished species. These data sets are collected at various spatial scales and over varying time periods. For example, Fisheries WA has databases that go back to the opening of their fisheries, data on the NPF is available from about 1970, and data on commercial catches in Queensland (CFISH) are available from 1988. Most information is now collected at a resolution of at least six nautical mile grids (usually on a daily basis). The introduction of vessel monitoring systems makes it possible to collect data on a much finer spatial scale.

Data collected independently of fisheries are not usually collected over large scales. One exception is the collection of data on fish, crustaceans, molluscs, macrobenthos, sediments, bathymetry and water quality in the Gulf of Carpentaria (at several instances in time—see CSIRO web site in section 4.2.3 for a summary of these datasets).

However, because of the size of the vessel used in these surveys, very little information was collected in water less than 20 m deep. Currents in the Gulf of Carpentaria are relatively well known. However, little is known of the currents west of Cape Arnhem in the study region.

Several agencies are using existing data sets and remote sensing to map and quantify the extent of coastal habitats. An example of this is the Coastal Habitat and Resource Inventory System of the Queensland Department of Primary Industries. One of the aims of this project is to map the mangroves for the whole coast of Queensland. However, the resolution of mapping, and the extent of ground truthing used in the mapping, can vary greatly between agencies. It is difficult to map the shallow seagrasses and coastal reefs using remote methods in the study region because of turbid waters. This means extensive sampling is needed to map these coastal habitats over the 6,000 km of coastline in the study region. An important component of such projects is the sampling design, and new methods of spatial analysis to estimate both the extent of habitat, and the reliability of the estimate.

4.2.3 Access to Data Sets

Various Federal and State agencies are custodians and providers of the data. Most of the information on data and their quality can be accessed through the Internet. The main sites for terrestrial information are:

- *Geological surveys* – AGSO; 1:250,000 digital maps of geology and other products
<http://www.agso.gov.au/front/products.html>
- Land systems, land unit surveys – CSIRO; land systems information mostly at 1:1,000,000–1:250,000 in hardcopy format for Kimberley, Victoria District, parts of Queensland; other surveys held by Federal and State agencies
http://www.nric.gov.au/nric/data/ndar_overview.html
<http://www.nt.gov.au/dlpe/>
<http://www.agric.wa.gov.au/>
<http://www.dnr.qld.gov.au/>
- *National soil surveys* – NRIC digital ‘Atlas of Australian Soils’, 1:5,000,000
http://www.nric.gov.au/nric/data/ndar_overview.html
<http://www.nric.gov.au/nric/data/nricdata/aussoils.htm>
- *Surveys held by State agencies*
<http://www.dnr.qld.gov.au/land/lris/lris/pages/mapsprod.html>
- *Vegetation and land condition surveys* – the main source is the SLATS project (QDNR)
<http://www.dnr.qld.gov.au/slats/index.html>
- *Pastureland and rangeland surveys* – MRC/Tohill and Gillies map on pasture lands, 1:4,000,000; now available in digital format from Land Resource Assessment and Management, Brisbane
- *Survey of important wetlands and information on biodiversity*– ERIN; various products and maps
<http://www.environment.gov.au/>
- *Climate data* – Bureau of Meteorology, various products
<http://www.bom.gov.au/climate/>
<http://www.dnr.qld.gov.au/longpdk/index.html>
- *Water resources and water quality data* – main custodians of water resource information are the various State agencies
<http://www.nt.gov.au/dlpe/http://www.wrc.wa.gov.au/waterinf/index.html>
http://www.dnr.qld.gov.au/water/water_reports/north/index.html

-
- *Topographical and digital elevation data* – AUSLIG; various products; digital topographic sheets; digital elevation models (18" and 9")
<http://www.auslig.gov.au/products/digidat/digindex.htm>
 - *Some other valuable sites with general information on resource and environmental data are:*
<http://www.nric.gov.au/nric/data/data.html>
http://www.environment.gov.au:80/marine/mcdd/agency_lists.html
http://www.erin.gov.au/edd/owa/edd_search2.category_list
 - *Centre for Social Research*
<http://www.ntu.edu.au/faculties/arts/csr.htm>

A summary of data sets (meta data) on the marine environment has been made by the Environment and Resources Information Network (ERIN) as part of the ‘Oceans Rescue 2000’ program. In November 1997, the Marine and Coastal Data Directory (MCDD or blue pages) contained over 300 data entries from 30 agencies. The meta data for the datasets collected by CSIRO Marine Research (MarLIN – Marine Laboratories Information Network) are also available.

Web sites with information on marine data sets and marine agencies are:

- <http://www.environment.gov.au/marine/mcdd/index.html>—summary of marine meta data from around Australia
- <http://www.marine.csiro.au/dmr/database/marlin>—summary of marine and coastal data sets held by CSIRO Marine Research:
- http://www.environment.gov.au/marine/natmis/national_network/national_network.html—summary of marine and coastal agencies around Australia
- <http://www.aims.gov.au>—summary of the Australian Institute of Marine Science
- <http://www.nt.gov.au/dpif>—summary of the Northern Territory Department of Primary Industries and Fisheries
- <http://www/dpi.qld.gov.au/fishweb/Welcome.html>—summary of Queensland Department of Primary Industries (Fisheries and Aquaculture)
- <http://www.env.qld.gov.au/environment/coast/parks>—information on marine parks in Queensland through the Queensland Department of Environment and Heritage

5 Stakeholder Perspectives

5.1 Introduction

Key issues for natural resource planning and management were identified by 107 people from 67 organisations across four jurisdictions in tropical Australia (Western Australia, Northern Territory, Queensland and Commonwealth; see Appendix A for a list of organisations consulted). This section synthesises their perceptions, which were expressed at face-to-face meetings. We have summarised them by jurisdiction and incorporated the discussions with Commonwealth organisations into the relevant State/Territory section. The perceptions are grouped in the categories of Integrated Resource Management outlined in Chapter 2 (technical issues, institutional arrangements and capacity development). The expressed research and development priorities of stakeholders have also been documented in this section.

5.1.1 Methods

Raw data were collected through face-to-face interviews with one or more people from each organisation, using a common interview format (Appendix B). At least one CSIRO researcher was present at the interviews. Notes taken during the interview were summarised and returned to the interviewees for comment on both their factual accuracy and intent. The final notes were evaluated using standard qualitative data assessment methods. To ensure confidentiality, comments are not attributed to individuals or agencies, and comments grouped in a ‘sector’ do not necessarily come from that sector.

As with any research involving interviews and interview material, there are some caveats. We attempted to interview a cross-section of stakeholders but could not interview them all. As stakeholder responses are guided by the questions asked they focused on broad natural resource planning and management issues and on regions where there were problems for integrated resource management. They do not necessarily discuss all the issues impacting on tropical Australia. Finally, because of the volume and diversity of material collected, a synthesis was made for this report, which necessarily required ‘filtering’ of raw material. Hence, the final responsibility for material presented here rests with the study team.

5.2 Stakeholder Issues and Information Needs

5.2.1 Western Australia

In Western Australia, the key issues for the sustainable development of tropical Australia were focused by stakeholders on three key Kimberley subregions: the Ord River Basin–Joseph Bonaparte Gulf (Ord/Bonaparte), Fitzroy River basin/Broome and north Kimberley (Table 19).

Technical

- *Management of the Ord River catchment* – While there is a substantial body of data for this region at the farm scale, particularly in terms of soils, stakeholders saw a need for improved baseline data across the entire

catchment, and not just the irrigation area. In addition, many stakeholders thought that Ord basin management needs to focus beyond the irrigation area to include the upper catchment and lower Ord, and also the impacts of the Ord system (and proposed changes such as Ord Stage II) on the marine resources of the Joseph Bonaparte Gulf. A better understanding of ground and surface-water hydrology in the irrigation area (and Ord Stage II) was seen as critical to the sustainability of the region. In the basin as whole, a better understanding of ecological processes (terrestrial and aquatic) was also seen as important.

- *Aquaculture development* – Many stakeholders mentioned the potential for aquaculture development throughout the Kimberley, especially in Broome, Derby and Lake Argyle, with also the possibility of pearl expansion in the north-west. However, while there has been some assessment of the biophysical issues associated with aquaculture development (FWA and KDC, 1996) neither the socio-economic impacts nor infrastructure requirements have been assessed. Because of the high costs of infrastructure and transport in this region, some members of industry considered the development of aquaculture in this region to be high risk.
- *Development in the Fitzroy basin* – Proposed infrastructure development for agriculture in the Fitzroy River basin was seen as an issue: in particular the proposal to grow cotton south of Broome and dam the Fitzroy River and develop groundwater resources was of concern. Changes in the flow regime of the Fitzroy could affect estuarine and marine ecosystems and the productivity of fisheries.
- *Management of feral animals, weeds, and fire* – Kimberley stakeholders saw management of feral animals, weeds, and fire, particularly on conservation and pastoral lands, as important.
- *Marine resource management* – Although some work has been undertaken, the current limited understanding of marine systems of the Joseph Bonaparte Gulf was seen as a constraint to planning and management by both terrestrial and marine stakeholders.

Institutional

- *Management of the Ord River catchment* – many stakeholders thought the Ord River catchment lacked an integrated planning and management focus, and they wanted better institutional arrangements to tackle catchment-scale issues.
- *Strategic planning for the Kimberley* – At the regional level, the lack of a strategic planning framework meant that stakeholder's aspirations for social and economic development as well as resource conservation and protection were not identified. The failure of previous planning processes to involve the broader community was noted, and the need to improve regional resource use planning highlighted.
- *Tourism planning* – The failure to integrate a tourism perspective in planning was seen as a problem, particularly given its current and projected contribution to the Kimberley economy.
- *Indigenous management* – Increasing Indigenous ownership of pastoral land in the Kimberley and the new management imperatives that this established were seen by many stakeholders to be a priority issue.

Capacity

- *Resources* – Lack of human and financial resources was seen as a fundamental constraint to natural resource planning and management in the Kimberley.
- *Access to information* – Stakeholders perceived this to be a major constraint, particularly given the geographic isolation of the Kimberley; tools were seen to be needed to integrate and make accessible existing data and information.
- *Participation in planning and management* – Availability of processes, structures and mechanisms to more effectively facilitate participation of a broad range of stakeholders was perceived as a key impediment to natural resources planning and management, particularly at the regional level.

5.2.2 Northern Territory

Issues identified by stakeholders in the Northern Territory largely focused on the Victoria River District, Katherine–Daly Basin and the greater Darwin Region (Table 20).

Technical

- *Development in the Katherine–Daly Basin* – Horticultural and aquaculture development was seen to be constrained by insufficient knowledge of the ground and surface-water resources of the region and their interaction.
- *Data and information* – Stakeholders identified the need to improve baseline and management-scale data, collate existing information and make it accessible.
- *Management of feral animal, weeds and fire* – Stakeholders saw an urgent need for effective management across all land tenures.
- *Marine resource management* – Although some R&D has been done, stakeholders identified a substantial lack of marine habitat mapping and development of marine conservation priorities.

Institutional

- *Institutional tension* – The most significant institutional issue in the Northern Territory was seen to be the tension between Government and Indigenous resource management agencies in determining management priorities for Aboriginal and non-Aboriginal land. There was broad agreement that, while this is found across northern Australia, it was far more pronounced in the Northern Territory.
- *Integrated resource management* – As in Western Australia, respondents cited the need for integrated approaches to resource management, better resource management information and the need to address Indigenous resource management issues.
- *Land access* – Stakeholders were unanimous that resolution of land access was the key to addressing broader land-management issues. Land ownership and access were seen to be more highly politicised in the NT than elsewhere.
- *Coordination* – Possibly due to the close relationship of the Northern Territory with the Commonwealth, NT stakeholders specifically noted the poor coordination of Commonwealth programs, particularly the process of obtaining grants.

Capacity

- *Resources* – Stakeholders clearly articulated that a key impediment to resource planning and management in the NT was a lack of staff and institutional capacity.
- *Institutions* – The development of agencies capacity for resource planning was seen as essential.
- *Access to information* – Stakeholders perceived this to be a major constraint, particularly given the geographic isolation of the region and the lack of tools to integrate and access existing data and resources.

5.2.3 Queensland

Issues identified by stakeholders in Queensland focused on the southern Gulf of Carpentaria and western Cape York Peninsula regions (Table 21).

Technical

- *Baseline information* – Lack of knowledge about the natural environment including water (ground and surface), marine (fisheries and pollution), tourism, agriculture (soil and water), economics (income flows), and the social environment was seen as a key constraint. In common with the rest of the north, the available baseline data are usually associated with specific resources (eg. fisheries), impact assessments of projects, or discrete academic work. Where a baseline had been measured (eg. as a result of the CYPLUS project), it was not at a scale required for management. In some cases, the information was seen to represent only non-Indigenous priorities.
- *Impacts of development* – There is strong pressure to develop resources in the southern Gulf of Carpentaria (mining) and on western Cape York (mining and intensive agriculture). Concern was expressed about the

impacts of rapid regional development on conservation, water management, land management, fisheries, infrastructure development and the provision of social services. Stakeholders identified a need to improve understanding of these impacts.

- *Recreational fishing* – Better understanding of the regional impact of a growing recreational fishery was an identified need.
- *Infrastructure development* – Coordinated infrastructure to facilitate resource development was needed.

Institutional

- *Strategic planning* – Many stakeholders identified the difficulty of supporting strategic planning in the Gulf and Cape regions because of the poor coordination between government sectors. It was felt that the southern Gulf of Carpentaria is currently the least coordinated region in tropical Australia in terms of resource management and planning.
- *Indigenous interests* – Regional-scale development was seen by some stakeholders as continuing to marginalise Aboriginal interests, even where those interests were supposedly catered for in some projects (eg. CYPLUS).

Capacity

- *Human resources* – Some agencies have not developed the required skills, and limited human and financial resources were problems.

Table 19. Summary of natural resource management issues identified by stakeholders in Western Australia.

	Technical	Institutional/Legal	Capacity
Agriculture	<p>Ord River Irrigation Area I & II</p> <ul style="list-style-type: none"> • Rising watertable and off-site deposition of sediment • Need for sustainable irrigation and efficient water use • Need for balance of environmental and consumptive use balances • Lack of effective hydrological monitoring and information, and difficulty in of cost effective establishment • Need for detailed hydro-geologic understanding of soils • Need to investigate possible impact of changed flow in Ord River (of Ord Stage II) on tourism and estuarine and marine fisheries • Information on sediment transport in drain management methods such as operation of silt traps/constructed wetlands • Need to review farm practices within broader resource management context <p>Other</p> <ul style="list-style-type: none"> • La Grange sub-basin understanding needed before major development for agriculture 	<ul style="list-style-type: none"> • Need for policy-level support of planning beyond the current spatial horizon (eg. incorporating impacts of changed flows on marine systems) • Existing institutional arrangements not well thought out, resulting in poor coordination of departments • State agencies often conflictive rather than constructive 	<ul style="list-style-type: none"> • Capacity to meet demand, in terms of both staff numbers and skills • Lack of resources to be involved in strategic planning
Environment	<p>Knowledge</p> <ul style="list-style-type: none"> • Significant lack of shared baseline data/understanding of state of regional natural resources • Limited ecological knowledge in relation to cause/effect, process understanding, systems dynamics <p>Water</p> <ul style="list-style-type: none"> • Significance of groundwater in tropical ecosystem management • Information on water use, allocation, and flows and also coastal waters, is critical • Environment discharges out of the Ord Irrigation Area into the Dunham River and Lower Ord Management • Maintenance of biodiversity at species and systems level • Management of feral animals, weeds and fire • Management of multiple- fire regimes 	<ul style="list-style-type: none"> • Lack of ecological basis to planning • Need for cooperation in research to gather key biophysical data • Land tenure and access • Lack of consistent environment standards between agencies • Lack of clear mission/brief and legislative integration at basin level for water resource management 	<ul style="list-style-type: none"> • Increasingly difficult to fund research even in partnership • Aging data sets • Limited knowledge of data availability • Lack of resources (financial, expertise) to undertake baseline research
Fisheries	<ul style="list-style-type: none"> • Aquaculture in Lake Argyle – complex ecological considerations; conflict between existing and potential fishery. Economics and markets for aquaculture production in this region • Oceanography – no work undertaken to understand region • Lack of process understanding of marine systems, particularly changes in flow regime and nutrient levels on function and production of these systems 	<ul style="list-style-type: none"> • Equity issue – access to fishing areas 	
Government	<p>Planning</p> <ul style="list-style-type: none"> • Lack of processes to establish priorities and undertake strategic analysis of issues • Lack of strategic planning in Ord catchment to coordinate resource management <p>Other</p> <ul style="list-style-type: none"> • Poor acknowledgment of importance of information in determining future needs • Lack of communication between agencies and stakeholders • Problems relating to remote areas (eg. cost of services) 	<ul style="list-style-type: none"> • Interest in land tenure/use/scale • Need for statutory power to bring resource management approaches together to coordinate use of those resources • Lack of an integrated approach to resource management obscures emerging issues 	<ul style="list-style-type: none"> • Lack finances to plan and define resources

	Technical	Institutional/Legal	Capacity
Human & Social Services	<ul style="list-style-type: none"> Regional sustainability includes need for monitoring to include social sustainability 	<ul style="list-style-type: none"> Need for cooperation in research to service socio-economic needs Allocation of effort in research biased toward economic criteria Need to make decisions mindful of distributive justice Decision-making often not transparent 	<ul style="list-style-type: none"> Demographic change – predicted increase in proportion of young people in the region—need to find sustainable jobs Cost of putting people in remote towns prohibitive
Indigenous	<ul style="list-style-type: none"> Infrastructure provision in Aboriginal communities Need to address social and community issues arising from low socio-economic status If Native Title is able to be acknowledged, and it is possible to negotiate coexistence, then there is the issue of use and management of natural resources 	<ul style="list-style-type: none"> Native title in Kimberley is yet to be addressed in operational and use Producers are focused on production and not broader land management issues 	<ul style="list-style-type: none"> Social issue in Kimberley is how to develop economic capacity of Aboriginal community
Minerals & Energy	<ul style="list-style-type: none"> Potential oil and gas expansion in north west Kimberley 	<ul style="list-style-type: none"> Definition of coastal waters in relation to high and low water mark is unresolved with large tidal flux 	
Research & Development	<ul style="list-style-type: none"> Need to explore, and incorporate different areas of knowledge in resource management systems 	<ul style="list-style-type: none"> Lack of university and CSIRO involvement in region 	<ul style="list-style-type: none"> Prohibitive cost of research Lack of scientific critical mass/capacity (CRC for SDTS has led to some effort on some issues)
Tourism	<ul style="list-style-type: none"> The region is experiencing exponential tourism growth, particularly in ecotourism, and is not sure how to manage this 	<ul style="list-style-type: none"> Need to integrate tourism perspective in regional planning 	<ul style="list-style-type: none"> Lack of resources forces reactive and subjective process without strategic focus
Inter-Sectoral	<p>Integration</p> <ul style="list-style-type: none"> Need for a model to enhance spatial and temporal connections between activity and impact Need ways to bring agriculture, power generation, and tourism, together Development of mechanisms and tools to integrate resource information Integrated use and management of water resources in the Ord <p>Baseline Information</p> <ul style="list-style-type: none"> Lack of baseline information—inventory and process understanding needed to fill large information gaps throughout Kimberley eg. in upper and lower Ord catchment Scale of available data is of limited relevance to planning and decision-making <p>Planning</p> <ul style="list-style-type: none"> Difficult to define resource-management relationships in environment of imperfect knowledge Lack of template, guidelines or strategic framework to underpin local activities <p>Other</p> <ul style="list-style-type: none"> Need for agreement of what does ecological sustainable development mean for/in the Kimberley Need to understand and develop historical resource management context for planning in the future planning 	<ul style="list-style-type: none"> Need to identify and coordinate strategic needs for north-west Kimberley coast There is a cycle of planning at the regional level, but few implemented outcomes Mechanisms needed to integrate resource information Develop structures to ensure that data collated in the region are properly managed, archived and accessed 	<ul style="list-style-type: none"> Skills may be lacking in some agencies Need for capacity building to enable participation in resource management and planning Need greater capacity for people outside government agencies to support R&D in region Probably greater skills in region than think

Table 20. Summary of natural resource management issues identified by stakeholders in the Northern Territory.

	Technical	Institutional/Legal	Capacity
Agriculture	<ul style="list-style-type: none"> • Increase in horticultural development in the Katherine–Daly • Issues relating to intensification of agriculture • Operational knowledge of groundwater and surface-water dynamics in relation to agricultural use 	<ul style="list-style-type: none"> • Land access, particularly Native Title • Need integrated regional planning to tackle multiple-use issues 	
Environment	<ul style="list-style-type: none"> • Clearing of land • Effective approaches to fire management • Weed control • Feral animals • Population growth – planning for growth in Darwin and Alice Springs, especially for suitable sites • Clearing of mangroves for residential and commercial purposes 	<ul style="list-style-type: none"> • Greenhouse—flow ons from international treaties 	<ul style="list-style-type: none"> • Too few staff • Capacity building needed to respond to regional issues • Need resources for meaningful participation in regional planning
Fisheries	<ul style="list-style-type: none"> • Landcare projects on the Mary River appear to have had a negative impact on fisheries • Lack of knowledge of land impacts on marine systems • Need for government to develop infrastructure and support to improve viability of fisheries • Marine pests—unknown impacts of ballast water discharge at ports in Gulf of Carpentaria • Lack of marine habitat mapping and priorities for marine conservation • Potential aquaculture development on Katherine–Daly 	<ul style="list-style-type: none"> • Recreational fishers increasingly significant force in decision-making • Access to land restricts possibility of aquaculture development 	<ul style="list-style-type: none"> • Lack of resources to undertake research
Govt		<ul style="list-style-type: none"> • Decision-making for natural resource development very political 	
Human & Social Services	<ul style="list-style-type: none"> • Planning for population growth, particularly in Darwin and Alice Springs 		
Indigenous	<ul style="list-style-type: none"> • Development of multiple-use strategies to achieve viability, defined in landowners’ terms • Future impacts of development on pastoral land currently without industrial pollution • Possibility of equitable collaboration of western science and traditional ecological knowledge • Incompatibility of biophysical capacity of the land and landholders economic development aspirations 	<ul style="list-style-type: none"> • Need for management of Aboriginal land in Aboriginal hands on Aboriginal terms • Tension between Government and Indigenous groups on Aboriginal land management by Aboriginal people • Lack of cohesion between Territory and Commonwealth agencies • Inaction on Woodward Commission recommendations for customary titles to seas • Political threats to continued private ownership of Aboriginal land 	<ul style="list-style-type: none"> • Capacity building needed among Aboriginal landowners for: planning and management, and participatory planning skills • Government decreasing rather than increasing Aboriginal land-management capacity • Lack of appropriate education opportunities • Lack of communications infrastructure and maintenance capacity for use of GIS in resource management

	Technical	Institutional/Legal	Capacity
Minerals & Energy	<ul style="list-style-type: none"> Land access for infrastructure and mineral development is a key issue New phase of mineral exploration (U/Diamonds/Au) and attendant problems 	<ul style="list-style-type: none"> Lack of capacity to grant valid title 	<ul style="list-style-type: none"> Access to labour Skills shortages
Pastoral	<ul style="list-style-type: none"> Need for improved pasture management outside coastal zone (north) and Douglas–Daly Damage to river banks by cattle Need for sustainable grazing and regional planning in the rangelands Development of areas for improved pasture needs to be examined more closely 	<ul style="list-style-type: none"> Processes for sustainable rangelands management need to be established 	
Research & Development	<ul style="list-style-type: none"> Need to determine real indicators of sustainability 	<ul style="list-style-type: none"> Research in resource-management arena must be about land use and not hindered by access to land 	<ul style="list-style-type: none"> Fragmentation of research Low critical mass of scientists in the north Lack of capacity in socio-economic/planning disciplines
Tourism	<ul style="list-style-type: none"> Need to develop effective approaches to cultural tourism 	<ul style="list-style-type: none"> Poor integration of tourism perspectives in regional resource-use planning 	
Transport & Infrastructure	<ul style="list-style-type: none"> Need to consider long-term resource development issues in infrastructure planning Energy and fuel costs in remote locations Poor electricity supply 		<ul style="list-style-type: none"> Lack of skilled labour for infrastructure development
Inter-Sectoral	<ul style="list-style-type: none"> Need for ecological assessment of changes in resource management policies to provide a scientific underpinning Deficiency in understanding the relationship between land and marine impacts; and among biophysical, economic and social systems Knowledge of how to handle mix of systems at all scales Lack of baseline knowledge (other than broadly descriptive) at a management scale How to detect change in biodiversity on land and in water State of development of industries and fine-tuning of resource development not there Development is based on boundaries on maps and not on biophysical boundaries 	<ul style="list-style-type: none"> Difficulty in accessing information Need to develop collaborative links to determine strategic approaches Lack of clear EIA procedures on Aboriginal land Multiplicity of bodies that consider themselves responsible for planning Strong competition between departments Need to institutionalise natural-resource management in development planning Different funding sources all require different administrative objectives Funding economies of scale and integration will make more sense Small bureaucracy allows for closer contact between agencies 	<ul style="list-style-type: none"> Government lacks the experience and skill at regional planning to address issues at the catchment level, although perhaps the capacity is growing

Table 21. Summary of natural resource management issues identified by stakeholders in Queensland.

	Technical	Institutional/Legal	Capacity
Agriculture	<ul style="list-style-type: none"> • Impacts from competing uses (eg. grazing vs. agriculture) • Impacts from broadscale development of agriculture • Water planning and management—interest in irrigation for peanuts and sugar • Impacts of changes in water flow on downstream ecosystems and fisheries production 		
Environment	<ul style="list-style-type: none"> • Potential contamination of waterways by heavy metals • Possible increase in shipping activities is likely to create environmental problems • Little thought given to date in terms of how to manage environment impacts of increased shipping • Recognition and protection of key conservation sites both on the land and at sea • Feral animals management • Effective management of impact of major resource development in relatively undeveloped region 	<ul style="list-style-type: none"> • Need to identify mechanisms for working with Aboriginal communities • Need to incorporate views of estuarine and marine stakeholders in planning water use and allocation 	<ul style="list-style-type: none"> • Poor appreciation by stakeholders of environment and what it can sustain
Fisheries	<ul style="list-style-type: none"> • Substantial concern about developments that could damage the quality of seafood (eg. contaminants in waterways) • Need to understand potential environmental impacts of aquaculture development in Gulf of Carpentaria • Lack of baseline and management information • Regional impact of recreational fishery • Maintenance and protection of inshore habitats, estuaries and river flows, and inshore environments • Concerned with offshore water quality and substrate quality • Habitat issues, including the carrying capacity of the ecosystem and damage to nursery areas (eg. prawns) • Impact of changes in water flow and nutrients on estuarine and marine ecosystems and fisheries production 	<ul style="list-style-type: none"> • Need for effective land-use planning for aquaculture 	<ul style="list-style-type: none"> • Limited financial resources • Lack of resource assessment capacity
Government		<ul style="list-style-type: none"> • Lack of integration and coordination of planning programs 	<ul style="list-style-type: none"> • Limited staff capacity in community-based planning • Planning capacity constrained by operational requirements • Limited technical capacity (data and software tools) • Limited capacity to do much developmental planning with communities • Serious time constraints and limited staff resources
Human & Social Services	<ul style="list-style-type: none"> • Communities having to respond to big pulse of development and trying to ameliorate its negative effects while also trying to take advantage of development • Impact on services from short-term transient population resulting from tourism 		

	Technical	Institutional/Legal	Capacity
Indigenous	<ul style="list-style-type: none"> • Involvement of Aboriginal people in development and resource issues • Need to get Aboriginal interests considered in natural resource management • Need for regional-level support for natural-resource management • Lack of Aboriginal issues in planning could result in a very complex regional situation • Recognition of Aboriginal perspectives on economy and resources 	<ul style="list-style-type: none"> • Involvement of Aboriginal people in development and resource issues • Lack of statutory guidelines for best-practice planning in resource management in Aboriginal affairs 	
Minerals & Energy	<ul style="list-style-type: none"> • Industry needs access to identify in-ground resources • Potential impact on groundwater supply, particularly Great Artesian Basin, by large mining operations 		
Pastoral	<ul style="list-style-type: none"> • Issues of water availability • Pasture and land degradation, and pasture management issues—infestation by exotic woody weeds, prickly acacia, rubber vine • Likelihood of significant changes in pastoral activities arising from live cattle exports. 		
Tourism	<ul style="list-style-type: none"> • Impact of recreational visitors (tourists, campers) 		
Transport & Infrastructure	<ul style="list-style-type: none"> • Lack of regional transport infrastructure • Coordinate and support infrastructure development to facilitate the development of all resource projects • Logical transportation route for resource exports • Accessibility problems—remote location, serviced by unsealed and poor-quality roads • Energy provisions—gas to Mt Isa will change the Gulf, as it opens up possibility for energy supply to other areas. 		<ul style="list-style-type: none"> • Marine pollution due to vessel oil-spills—do not have the physical capacity to clean up
Inter-Sectoral	<ul style="list-style-type: none"> • Concern over seemingly repetitive consultation, and scepticism about delivery of strategies and solutions 	<ul style="list-style-type: none"> • Limitation to ability to coordinate resource-management decisions in Gulf • Coordinated approach needed for resource planning and management 	

5.3 Stakeholder Research and Development Priorities

This section describes the priorities for research and development identified during meetings by stakeholders in the four jurisdictions examined. As in the previous section, we have summarised the responses by State and incorporated Commonwealth priorities within the appropriate State.

5.3.1 Western Australia

The following were identified by stakeholders as research priorities for the Kimberley region.

Technical

- Ord Stage I – Management of the current irrigation area was a high priority.
- Stakeholders stressed the need to investigate off-site impacts of irrigated agriculture, including:
 - down-stream impacts on estuarine and marine resources;
 - sediment and nutrient relationships in estuarine and marine ecosystems budgets for materials flux;
 - endosulfan behaviour;
 - sediment control and sediment-trap design; and
 - chemical and sediment interactions.
- Improve hydro-geological understanding to guide irrigation management and development.
- Alternative methods of pest management (eg. non-chemical) for Ord Stage II and the projected large-scale cotton cropping in the west Kimberley.
- Mechanisms to integrate available information.
- At the systems level, stakeholders saw a critical need to develop ecological systems understanding. Previous work on farm or enterprise levels was seen as being mismatched with planning and management needs. The Ord system in particular was an opportunity to examine its highly modified ecosystem as a guide to planning in other regions.

Institutional

- Strategic plans to coordinate participative planning across scales and jurisdictions for multiple-use and management, particularly in the Ord.
- Institutional structures for integrated management, particularly in relation to the Fitzroy River basin and the north Kimberley.

Capacity

- Mechanisms to develop planning and management capacity in Aboriginal communities should be devised urgently.
- A similar need for dispersed pastoral communities was identified.

5.3.2 Northern Territory

Stakeholders identified the following topics as research priorities for the Northern Territory.

Technical

- Marine-habitat mapping; its lack constrains identification of marine conservation priorities (eg. seagrass habitats for dugong, mangrove mapping).
- Sustainable use of wildlife.

-
- Practical indicators for pastoral sustainability that incorporate social, economic and ecological measures.

Institutional

- Best practice for participatory planning.

Capacity

- R&D to support multiple-use planning and management on pastoral properties acquired by Aboriginal people.
- Gap in knowledge and understanding of natural resources (inventory and process) at landscape, catchment and regional scales.
- Although integrated catchment management has been used in the Mary River for 2.5 years, R&D was needed to underpin broader catchment management.
- New methods of facilitating access to information.

5.3.3 Queensland

Stakeholders in Queensland identified the following as research priorities for the southern Gulf of Carpentaria and western Cape York.

Technical

- Marine habitat mapping; the lack of it constrains marine conservation (eg. dugong habitat, seagrass, and mangrove mapping).
- Practical indicators for pastoral sustainability that incorporate social, economic and ecological measures.

Institutional

- Best practice for methods to improve stakeholder participation in planning.

Capacity

- R&D for multiple-use planning and management on pastoral properties.
- Gap in knowledge and understanding of natural resources (inventory and process) at landscape, catchment and regional scales.
- New methods and tools for facilitating access to existing natural-resource information sources.

5.4 Summary – A Regional Perspective

The issues and R&D priorities identified by stakeholders in this study are consistent with those identified by previous reviews and reports exploring similar issues in the north (see Chapter 4), or in natural resource management in general (eg. ASTEC, 1993; OND, 1994; ANZMECC and ARMCANZ, 1996; IC, 1997; McLeod *et al.*, 1997; Dale and Bellamy, 1998). Stakeholders expressed the view that integration of these reports at a systems level would be valuable, and that the implementation of their recommendations was still a priority.

In summary, the key issues identified by stakeholders were:

- At the broadest level, natural-resource managers are facing increasing pressures for development in a region where data and process understanding are relatively scarce. Concomitantly, there is a mismatch between the scale of existing data and management needs. Critically, sustainable natural resource planning and management of the north is fundamentally constrained by the lack of social, economic, ecological and marine systems understanding.
- The need for coordinated and strategic approaches to natural-resource planning and management, as well as the R&D effort to support them, was clearly articulated across all jurisdictions. Further, natural-resource

planning and management needed to focus at multiple scales (eg. paddock, farm, catchment), to deal with cumulative impacts over time and to define the relationship between farm, landscape and catchment management. In particular, the integration and coordination of research and management across terrestrial and marine environments was seen as critical. A corollary was that management practices and research concentrating solely on biophysical resources are no longer appropriate. Future research and management also needs to take into account cultural context and diversity. There was, therefore, a broad belief that the community must be actively involved in deciding and acting on research and management priorities.

- Indigenous resource-management is a key issue in northern Australia. Most sectors stressed the need to place Indigenous issues and Indigenous involvement in natural resource planning and management on the mainstream agenda. Similarly, resourcing of Indigenous research and development needed review. Despite the demographics of the region, Indigenous aspirations and rights in natural-resource planning and management are still not recognised. In particular Native Title is not being incorporated into broader land-use objectives. Further, Aboriginal communities and agencies are poorly resourced for participation in broad planning. Specific issues were the need for parity between Indigenous tenure systems and agency management boundaries, and the need to develop multiple-use strategies on Aboriginal-controlled land to achieve viability on the landowners terms.

Stakeholders also commonly identified the lack of capacity in existing institutions to facilitate effective natural resource planning and management. Further, institutional arrangements should be examined to develop more cooperative and coordinated approaches to research and development, government services and administration, and resource management and planning. This includes a rationalising of resource management legislation to address:

- The lack of coordination and integration at regional scale;
- The lack of broad stakeholder representation and participation in regional decision-making;
- The weakness and inaccessibility of the information base: stakeholders unanimously wanted this remediated. A key aspect was the need to enhance transfer of information between researchers, managers and stakeholders across catchment, estuary and marine systems. The need to upgrade—in some cases develop—information technology to support that was seen as a fundamental part of that process. Further, there is poor integration of Indigenous knowledge in broader resource management practice and a lack of culturally and ethically appropriate mechanisms to do so.

Related to the issues identified above was the belief that resources for activities in northern Australia are currently inadequate. The ability of stakeholders at all levels to participate effectively in regional planning is seriously constrained by a lack of staff, the prohibitive cost of research and development in the region, and the need to develop skills in all stakeholder groups. Further, research capacity was limited by the lack of resident qualified staff.

Stakeholders commonly focused on issues of lack of baseline data, integration and systems understanding. They suggested:

- Methods be developed to integrate and synthesise existing resource management information and improve access to it. There was a consensus that the existing data were not readily accessible.
- Better understanding of natural resource systems, including basic ecological systems dynamics and the socio-economic aspects of natural-resource management was seen as critical. Data collection should focus on systems-level research, and particularly should seek to correct the imbalance between biophysical and socio-economic data.
- Research into best practice for participatory planning in remote regions and Indigenous communities was a high priority. Participatory approaches to regional planning were believed to be the most suitable mechanisms and methods suited to the needs of northern stakeholders were needed.
- Regional-scale indicators of sustainability were badly needed. Much research and management practice refers to sustainability, but without there yet being an agreed measure of what that means at the regional scale, particularly in terms of social and ecological measures.
- Cost effective methods for collating accurate management-scale natural-resource inventory or baseline data were needed.
- Methods of exploring the impacts of terrestrial resource management activities on marine systems should be developed. Stakeholders across the north wanted research on the interactions between terrestrial and marine resource uses and activities.

6 Identifying a Geographic Focus for Research and Development in Tropical Australia

6.1 Introduction

Having outlined stakeholder perceptions of key issues and research and development priorities for tropical Australia, it is clear that many of the natural-resource planning and management issues identified are common to all jurisdictions. However, given the limited resources available, R&D effort necessarily must focus on one or two regions. Stakeholders commonly referred to a number of generalised ‘regions’ across tropical Australia, namely (Figure 9):

- Broome–Roebuck
- Fitzroy River/King Sound (Fitzroy/King)
- North Kimberley
- Ord River/Joseph Bonaparte Gulf (Ord/Bonaparte)
- Victoria River/Joseph Bonaparte Gulf (Victoria/Bonaparte)
- Katherine River/Daly River–Joseph Bonaparte Gulf (Katherine/Daly/Bonaparte)
- Darwin Region
- Southern Gulf of Carpentaria
- Western Cape York Peninsula

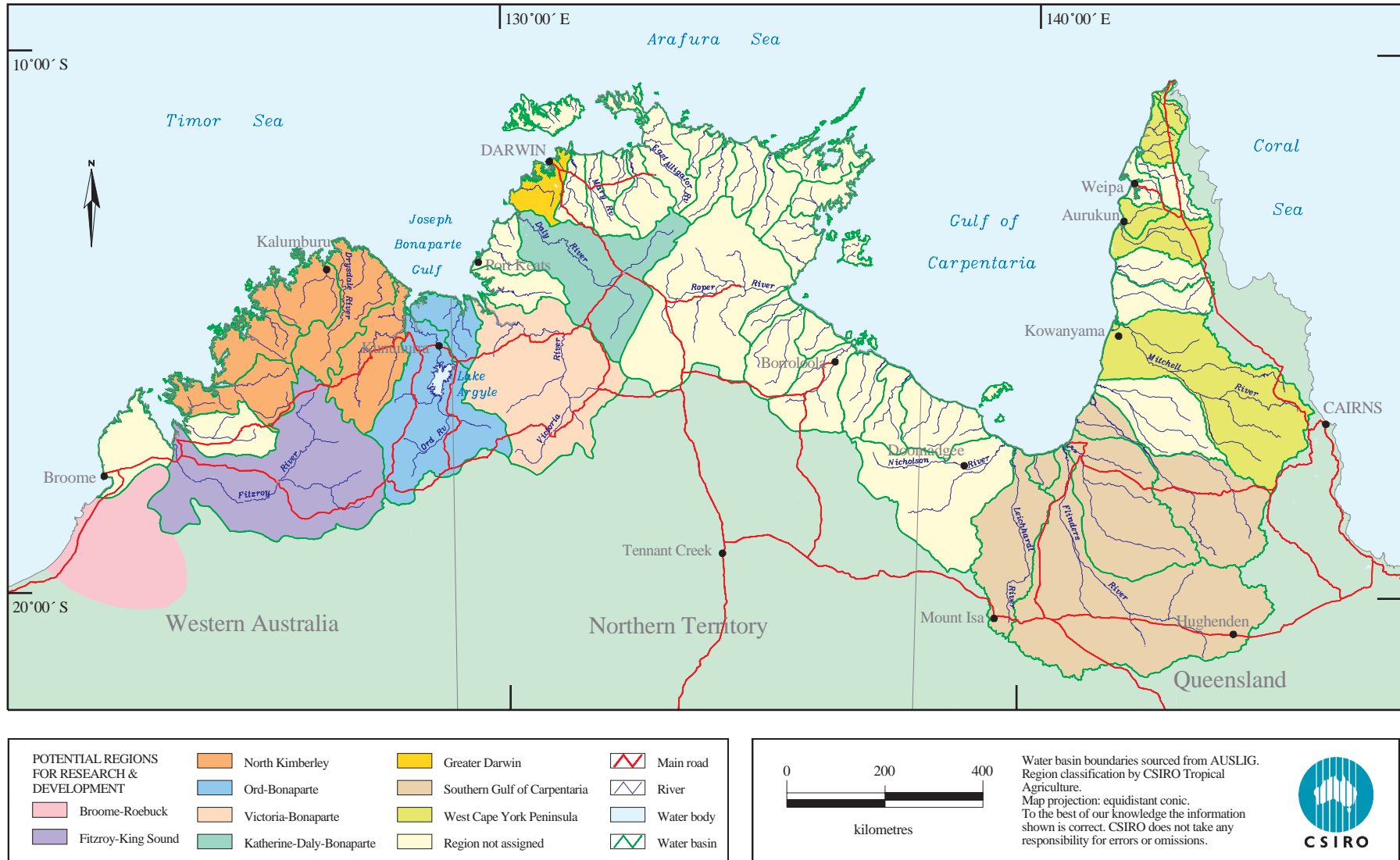
In this section we attempt to provide a focus for potential R&D by objectively assessing these regions, using a five-stage analytical framework. The assessment is based on the following:

- the recently completed Meat and Livestock Australia Scoping Study (Roth *et al.*, 1998), which identifies catchments in northern Australia most at risk from grazing management practices;
- a marine-threats analysis of the main issues affecting marine-resources management and the likelihood of those issues arising in the regions identified;
- the desktop review of natural-resource planning and management and of institutional, social and economic issues;
- an assessment of the significance of capacity-related issues to integrated resource management, based predominantly on interview material; and,
- an assessment of how R&D could support integrated resource management in the region.

Using this framework, the regions were assessed with the aid of evaluation tables (Massam, 1988), which are a simple multi-criteria decision-making technique where the highest aggregate score indicates a higher relative ranking for future R&D. Although this approach is subjective in the assignment of ranks, there is consistency within and between rankings. Further, the ranking given in each case is relative to each other region, not absolute. Therefore, a high score does not make a region intrinsically better than other regions.

It is common to identify and rank stakeholders according to either the impact of a proposal on them, or the influence they might have on the outcome. That ranking is then used to weight responses to issues to ensure that appropriate consideration is given to issues dependent on stakeholder importance. We have not chosen this approach, as insight into key resource management issues is independent of power to influence those issues.

Figure 9. Potential regions for research and development.



6.2 Analysis of Regions

The criteria used within each stage of the analytical framework are explained below. Five broad categories were considered: marine threats (Table 22), significance of environmental, economic and social issues (Table 23), effectiveness of institutional arrangements (Table 24), capacity issues (Table 25), and potential for effective research (Table 26). In each of these tables a score of 1 indicates a low value, and 5 a high value. The mean result from each table was aggregated to rank priority research regions (Table 27). These results indicate **potential** R&D opportunities; any further decisions would need to be negotiated with regional stakeholders.

6.1.1 Meat and Livestock Australia Scoping Study

Following a review of information on the effects of grazing-land management on water and nutrient cycles and the downstream fluxes of water, sediment and nutrients in northern Australia (Hook, 1997), the North Australia Program of Meat and Livestock Australia Phase 3 (NAP3) commissioned a scoping study (Roth *et al.*, 1998) to:

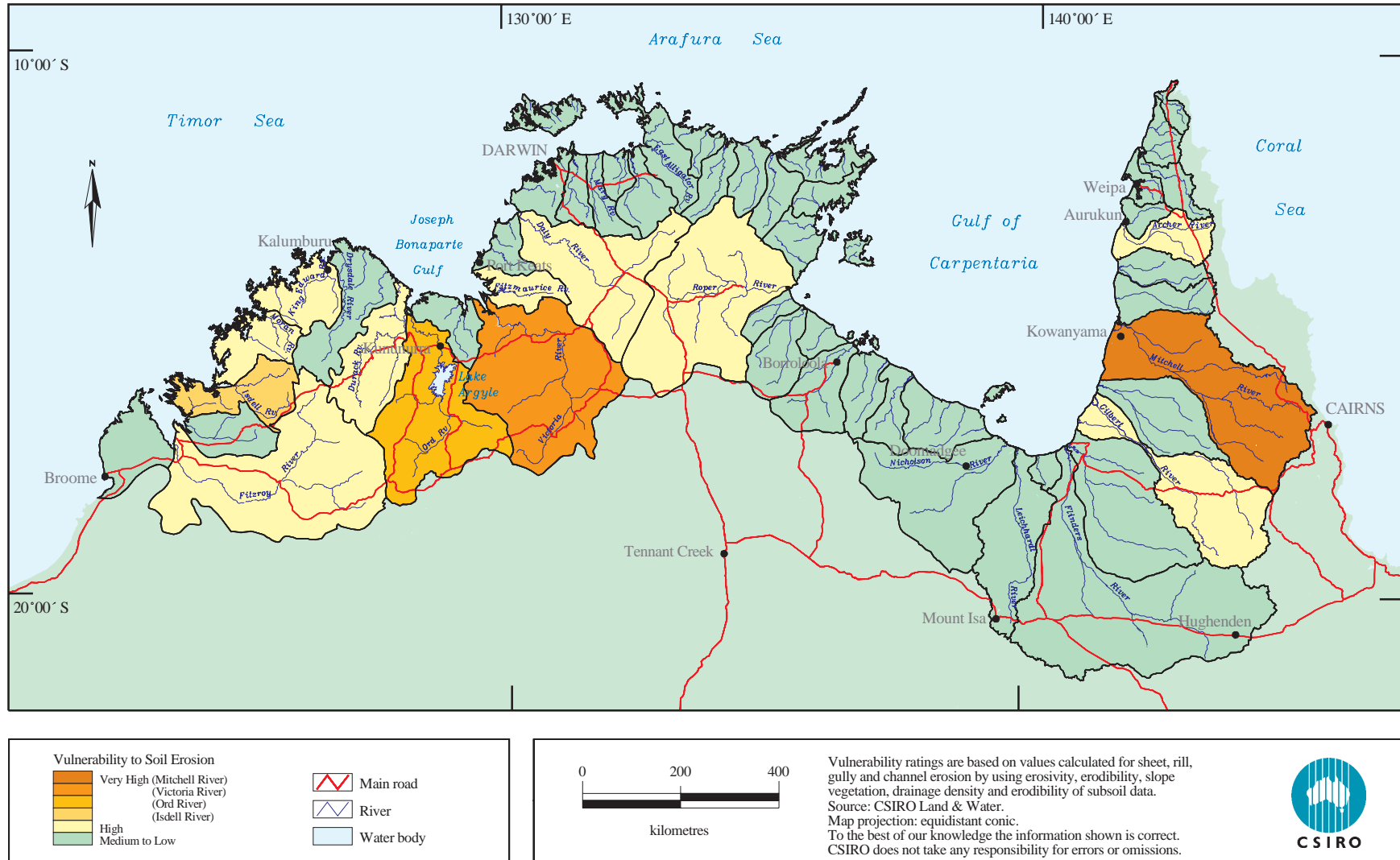
- collate and review existing information on research projects studying water quality and nutrient flow issues as related to grazing management in Northern Australia and identify priority issues in need of new or further research within the context of the recommendations provided by Hook's review;
- assess the relative potential vulnerability of grazed catchments across Northern Australia and evaluate perceived risks to water quality and nutrient flows as related to soil types, current stocking pressures/grazing management practices and other land uses; and
- provide NAP3 with recommendations on potential focus catchments for research into grazing effects on catchment response and optimum implementation through a major multi-agency research group.

The scoping study recommended that future work on catchment management, water quality and nutrient flows as related to the northern beef industry be primarily focused on:

- impacts of grazing management on sediment generation and nutrient loss at scales ranging from hillslope to catchment;
- quantification of key determinants of sediment, nutrient and overland flow processes at paddock, catchment and landform scales; and
- modelling of the process to enable extrapolation to other catchments in Northern Australia.

Five of the 132 catchments assessed were short-listed (Burdekin, Burnett, Fitzroy (QLD), Ord, Victoria). Figure 10 shows the vulnerability of catchments in this scoping study's region to erosion, a key determinant of the assessment. The final ranking placed Victoria and Ord as highest priority within the scoping study region

Figure 10. Vulnerability to soil erosion of key catchments in study area.



6.1.2 Marine Threats Analysis

To assess the threats to the marine environment in different regions across northern Australia, we summarised the information for different issues (see below) from the literature (Chapter 3–4) and stakeholder interviews (Chapter 5). We also took into account the potential threats from different activities in a catchment. This is very much a qualitative assessment of marine threats. Where possible, a score of 1 (minor threat) to 5 (major threat) was assigned to each issue; note that these ranks are relative within categories, but not between categories. However, this was not possible for ‘Traditional knowledge’ and ‘Marine protected areas’, as more detailed information is required than is currently available.

The information from the literature was obtained mainly from the State of the Marine Environment Report for Australia (SOMER – Zann (1996), Roth *et al.* (1998), the Australian Bureau of Statistics (ABS – McLennan (1996) and the Interim Marine and Coastal Regionalisation for Australia (IMCRA, 1998). Other reports deal with more specialised issues (eg. aquaculture, tourism, decision-matrices). In considering our summary of marine threats, it is important to note:

1. that the matrix for marine threats is a summary of our current knowledge and will change as the SOMAR reports for the States and territories are updated; and
2. in some cases (eg. Broome/Roebuck and North Kimberley) little information was available to rank the issues.

From the fishing sector’s perspective (commercial, recreational and traditional), catchments cannot be separated on the value of their marine fisheries—quite significant commercial and recreational fisheries are found in all regions of tropical Australia. However, the commercial fishing industry believes that R&D should concentrate on those areas where the issues or potential issues are greatest. The matrix highlights that the issues are greatest in the Ord/Bonaparte, followed by the Fitzroy/King Sound and Western Cape York regions.

Eleven categories of potential marine threat were identified and criteria for each developed, namely:

1. Agricultural land:
 - Erosion of cropping land (soil loss from cropping land)
 - Erosion of grazing land (soil loss from grazing land)
 - Urban expansion (urban expansion into land suitable for agriculture)
2. Water quality:
 - Surface-water nutrient enrichment (increased loading of nitrogen and phosphorus from rural, industrial and urban sources)
 - Pesticides (contamination of water by pesticides from rural, industrial and urban areas)
 - Impact on surface-water biota (change in natural water quality sufficient to adversely affect aquatic flora and fauna)
 - Groundwater quality (overall salinity, nutrient enrichment and pesticide levels in groundwater)
3. Water quantity:
 - In-stream and off-stream water use conflicts (competing demands between off-stream water users—urban, rural, industrial)
 - In-stream water use (environmental, recreational)
4. Mineral resources:
 - A measure of the potential for mineral resource development that could impact marine resources. Scoring for this criterion was as follows: 1 = No major mineral resources; 2 = One type of mineral resource; 3 = Two types of mineral resources; 4 = Three or more types of mineral resources
5. Offshore mineral exploration:
 - A measure of the potential for mineral exploration with potential to impact marine resources. Scoring for this criterion was as follows: 1 = Little or no mineral resources; 2 = Application for exploration licence withdrawn; 3 = Area under application for exploration licence; 4 = Area with licences and applications
6. Natural habitat:
 - Stream bed and bank instability (changes to the bed and banks of streams that affect existing property, infrastructure and habitat)
 - Coastal wetland habitat loss (loss of natural flora and fauna habitat in estuarine and tidal wetlands)
 - Barriers to fish migration (impact on the up—or down—stream migration of fish resulting from artificial barriers on watercourses)

-
7. Fishery value:
 - A relative measure of fishery value. Scoring for this criterion was as follows: 1= Very Low; 2 = Low; 3 = Medium; 4= High; 5 = Very High
 8. Aquaculture potential
 9. Tourism potential
 10. Traditional knowledge
 11. Marine protected areas (how well the region is covered by protected areas).

Results of the marine threats analysis are presented in Table 22.

6.1.3 Significance of Environmental, Social and Economic Issues

An appropriate location for research on integrated resource management is where the research could prevent or reverse unsustainable outcomes from poor management. The following criteria were used to incorporate these issues into a matrix for decision analysis.

1. *Magnitude of environmental issues*: what is the relative importance or significance of likely resource management issues in a region (eg. Ord Stage II *cf* agriculture expansion in the Southern Gulf)?
2. *Extent of environmental issues*: what are the spatial and temporal extents of resource management issues?
3. *Tractability (manageability) of R&D on environmental issues*: can the resource management issues be assisted by research and development?
4. *Extent of variation in regional residential development and employment*: how varied are the residential and employment patterns? This criterion is an indicator of potential pressure on natural resources in a region.
5. *Degree of population change*: to what extent might the population structure be changing (since a population increase is likely to increase pressure on regional natural resources)?
6. *Significance to State and national economies*: what contribution does (or possibly will) the region make to State/Territory and national economies?
7. *Degree of economic change*: to what extent is the region's economic focus changing, and does that increase or decrease pressure on natural resources?
8. *Complex land-use leading to resource conflicts*: does the region have high multiple use, with multiple-use rights, that are resulting in conflict between resource users?
9. *Tractability of resource-use conflicts*: can research and development contribute to the resolution of some of these conflicts, or are they entirely political?
10. *Potential for significant resource development*: is the region likely to undergo substantial resource development?

On the basis of the above environmental, economic and social issues, the Ord/Bonaparte was the most attractive for R&D, followed by the southern Gulf of Carpentaria, Western Cape York and Victoria Bonaparte (Table 23). The Ord/Bonaparte region had a rank of five on six of the issues and four on the other issues.

6.1.4 Institutional Arrangements for Integrated Regional Resource Use

Of the criteria for assessment of institutional effectiveness (Chapter 2), only the following can be validly used in the context of this scoping study. A full examination of institutional arrangements and their effectiveness would be an appropriate initial research program in any of the regions. For the criteria selected, a score of 1 represents a low, and 5 a high, rating of the likelihood of research improving regional institutions for resource management (Table 24).

1. *Integrates national and local priorities* – institutional arrangements should reflect and respond to changes in national, regional and local resource management goals.
2. *Allows for representation of affected parties* – involve community and private sector stakeholders in natural resource planning and management institutions and make the institutions accountable to those stakeholders.
3. *Level of political support* – without adequate support, plans are not to implemented, and therefore research outcomes do not influence resource management practices.
4. *Possesses appropriate technical capacity* – ability to generate reliable information on alternative solutions to problems; it includes the production of required data and predictive modelling.

-
5. *Encourages coordination to avoid unnecessary jurisdictional overlap* – coordination not only of government units, but also across political and administrative boundaries, programs and relationships with other institutions.

In terms of the effectiveness of the institutional arrangements in potential research regions, the Ord/Bonaparte again ranked highest, followed by Broome/Roebuck and the Fitzroy/King Sound (Table 24). The total scores for the five criteria for assessing institutional arrangements ranged from 10 to 19.

6.1.5 Capacity

A key tenet of integrated resource management is that stakeholders should participate in resource planning and management. Their capacity to do so is constrained by issues listed below, some of which R&D can help resolve. This assessment is mainly based on interviews. For the criteria selected, a score of 1 represents a low rating and of 5 a high ranking (Table 25).

1. *Adequate staff resources*: are there enough qualified people to support significant R&D in the region? This also covers the resources available for staff to participate in research programs.
2. *Training and skill levels of staff*: are there enough people with the skills and training to support R&D?
3. *Experience and continuity of staff*: is there a high ‘turn-over’ of staff and are staff experienced or inexperienced?
4. *Transport infrastructure*: what are the transport options (eg. port, airstrips) to facilitate resource development and access for research?
5. *Communications infrastructure*: is the communications infrastructure sufficiently well developed for stakeholders to access regional information or R&D outputs?
6. *Capacity of institutions to participate in resource management*: are institutions structured and staffed to participate in R&D for regional planning?
7. *Availability of financial resources*: is there financial support for R&D in the region and is it available for access by new research programs? (It is not desirable to divert resources from existing regional stakeholders.)
8. *Presence of structures to attract finances*: does the region have existing agencies with a record of attracting R&D funding or that would be able to service such a commitment?
9. *Availability of natural resource data*: how much natural resource data does the region have recorded, and are those data at a management scale?
10. *Ability of stakeholders to access data*: can regional stakeholders access the data and are they in a format that can be understood and interpreted?
11. *Balance of available data*: are the available data heavily concentrated in one discipline, or is there a mix?

In terms of research capacity, the Ord/Bonaparte and the Darwin region had the highest total scores, followed by Broome/Roebuck, Katherine/Daly–Bonaparte and Western Cape York (Table 25)

6.1.6 Research and Development

The final evaluation table focuses on issues relating to the potential impact of R&D on natural resource planning and management.

1. *Potential benefits*: are there significant benefits likely from possible R&D?
2. *Likelihood of capture*: is it likely that these benefits will be adopted by resource management agencies and other stakeholders, either immediately, or with an investment in capacity development?
3. *Basic data*: are there any baseline data (biophysical, socio-economic) that would facilitate a R&D project or would there need to be a significant investment in baseline data?
4. *Process understanding*: to what extent are environmental or resource management processes researched or understood in the region?
5. *Existing R&D effort*: is there already a significant R&D investment in the region, and would any proposed new research duplicate or compete with that effort?
6. *Financial feasibility*: could potential research options attract funding as well as provide a return on research investment?

-
7. *Collaborative opportunities*: are there opportunities for regional R&D or management agencies to collaborate in potential research projects?
 8. *Potential for spin-off benefits*: are the outcomes of research likely to be transferable to other resource management contexts, or generate other research projects in the same region?
 9. *Chances of technical success*: are the research needs of the region beyond the technical scope of foreseeable research capacity?

Table 26 presents the results of this analysis.

Table 22. Significance of threats to marine resources in potential research regions – ranked from 1 (lowest) to 5 (highest).

Criteria		Broome– Roebuck	Fitzroy– King Sound	North Kimberley	Ord– Bonaparte	Victoria– Bonaparte	Kath/Daly– Bonaparte	Darwin Region	Southern Gulf	Western Cape York
Agricultural land	Cropping land – erosion	1	3	1	4	1	1	2	2	2
	Grazing land – erosion	1	3	1	4	1	1	2	4	3
	Urban expansion	1	1	1	1	1	1	3	1	1
Water quality	Nutrient enrichment	1	4	1	4	1	2	2	2	1
	Pesticides	1	2	1	2	1	2	2	1	1
	Impact on biota	1	4	1	4	1	2	2	2	2
	Ground water quality	1	3	1	3	1	2	2	2	3
Water quantity	Water use conflict	1	4	1	4	3	3	2	2	2
Mineral resources		1	3	3	3	3	4	1	3	1
Offshore mineral exploration		1	1	2	4	1	2	1	1	2
Natural habitat	Stream channel instability	1	2	1	2	2	2	2	3	2
	Loss of coastal wetlands	1	3	1	3	3	3	3	1	1
	Barriers to fish migration	1	2	1	2	2	2	2	2	2
Fishery value	Recreational	3	4	4	4	4	4	3	2	4
	Commercial	2	5	2	5	5	5	1	4	5
Aquaculture potential	Freshwater	2	4	1	4	1	1	3	1	0
	Estuarine	2	3	3	3	1	1	3	2	0
	Marine	1	2	2	2	2	2	1	3	5
Tourism potential	Coastal	5	2	4	2	2	2	2	3	3
	Marine	4	1	3	1	1	1	2	1	1
Traditional knowledge	Existing	Substantial	Substantial	To be determined	To be determined	To be determined	To be determined	Substantial	Substantial	Substantial
	Potential to capture	To be determined	To be determined	To be determined	To be determined	To be determined	To be determined	To be determined	To be determined	To be determined
Marine protected areas	Existing or planned	Yes	Yes	Yes	Yes	Yes	Yes	Yes	To be determined	To be determined
Mean		1.65	2.8	1.75	3.05	1.85	2.15	2.05	2.1	2.1

Table 23. Significance of environmental, economic and social issues in potential research regions – ranked from 1 (lowest) to 5 (highest).

<i>Criteria</i>	<i>Broome– Roebuck</i>	<i>Fitzroy–King Sound</i>	<i>North Kimberley</i>	<i>Ord– Bonaparte</i>	<i>Victoria– Bonaparte</i>	<i>Katherine Daly– Bonaparte</i>	<i>Darwin Region</i>	<i>Southern Gulf of Carpentaria</i>	<i>Western Cape York Peninsula</i>
<i>Magnitude of resource management issues</i>	3	3	2	5	4	4	3	4	4
<i>Extent of resource management problems</i>	2	2	3	4	3	3	2	5	4
<i>Tractability of resource management problems</i>	3	3	3	4	3	3	3	3	3
<i>Extent of regional residential and employment variability</i>	5	5	2	5	5	5	4	5	5
<i>Extent of population change</i>	4	3	2	5	4	4	4	5	5
<i>Region of significance to State/national economy</i>	2	2	2	4	3	4	4	4	3
<i>Degree of economic change</i>	3	2	3	5	4	4	3	5	4
<i>Complex land use leading to resource conflicts</i>	3	5	3	5	3	4	3	5	4
<i>Tractability of resource use conflicts</i>	3	3	3	4	2	3	2	2	3
<i>Significant resource development</i>	2	4	2	5	5	5	4	4	4
Mean	3	3.2	2.5	4.6	3.6	3.9	3.2	4.2	3.9

Table 24. Effectiveness of institutional arrangements in potential research regions – ranked from 1 (lowest) to 5 (highest).

<i>Criteria</i>	<i>Broome– Roebuck</i>	<i>Fitzroy–King Sound</i>	<i>North Kimberley</i>	<i>Ord– Bonaparte</i>	<i>Victoria– Bonaparte</i>	<i>Katherine Daly– Bonaparte</i>	<i>Darwin Region</i>	<i>Southern Gulf of Carpentaria</i>	<i>Western Cape York Peninsula</i>
<i>Integrates national and local priorities</i>	4	4	4	4	3	3	3	3	3
<i>Allow representation of impacted parties</i>	3	2	2	4	2	2	2	1	3
<i>Engender political support</i>	3	4	3	4	4	4	3	2	3
<i>Posses appropriate technical capacity</i>	4	3	2	4	2	2	3	3	3
<i>Encourage coordination to avoid unnecessary jurisdictional overlap</i>	3	3	3	3	2	2	2	1	1
Mean	3.4	3.2	2.8	3.8	2.6	2.6	2.6	2	2.6

Table 25. Significance of capacity-related issues in potential research regions – ranked from 1 (lowest) to 5 (highest).

<i>Criteria</i>	<i>Broome– Roebuck</i>	<i>Fitzroy–King Sound</i>	<i>North Kimberley</i>	<i>Ord– Bonaparte</i>	<i>Victoria– Bonaparte</i>	<i>Katherine Daly– Bonaparte</i>	<i>Darwin Region</i>	<i>Southern Gulf of Carpentaria</i>	<i>Western Cape York Peninsula</i>
<i>Adequate staff resources</i>	2	2	2	3	2	2	3	2	2
<i>Training & skill levels of staff</i>	3	3	3	4	3	4	4	3	4
<i>Experience & continuity of staff</i>	2	2	2	3	2	2	2	2	2
<i>Transport Infrastructure</i>	4	2	1	3	2	3	5	2	2
<i>Communications Infrastructure</i>	4	2	1	4	3	4	5	2	2
<i>Capacity of institutions to participate in resource management</i>	4	4	4	4	3	3	3	2	3
<i>Availability of financial resources</i>	4	3	2	5	4	4	5	3	4
<i>Presence of structures to attract finances</i>	4	4	3	4	3	3	4	2	3
<i>Availability of natural resource data</i>	2	2	2	3	2	2	2	2	2
<i>Ability of stakeholders to access data</i>	2	2	1	3	2	2	4	2	2
<i>Balance of available data</i>	1	1	3	3	2	2	2	3	3
Mean	2.91	2.45	2.18	3.55	2.55	2.82	3.55	2.27	2.64

Table 26. Potential for effective research and development in potential research regions – ranked from 1 (lowest) to 5 (highest).

<i>Criteria</i>	<i>Broome– Roebuck</i>	<i>Fitzroy–King Sound</i>	<i>North Kimberley</i>	<i>Ord– Bonaparte</i>	<i>Victoria– Bonaparte</i>	<i>Katherine Daly– Bonaparte</i>	<i>Darwin Region</i>	<i>Southern Gulf of Carpentaria</i>	<i>Western Cape York Peninsula</i>
<i>Potential benefits</i>	3	3	3	5	4	4	3	4	4
<i>Likelihood of capture</i>	3	4	3	4	4	4	3	4	4
<i>Basic data</i>	1	1	2	3	2	2	3	3	4
<i>Process understanding</i>	1	1	1	2	1	1	1	1	1
<i>Existing R&D effort</i>	3	2	2	3	4	3	3	3	3
<i>Financial Feasibility</i>	3	3	2	3	3	3	4	3	3
<i>Collaborative opportunities</i>	2	3	3	5	4	3	3	3	4
<i>Potential for spinoff benefits</i>	2	4	3	4	4	4	3	3	3
<i>Chances of technical success</i>	2	3	4	4	3	3	3	3	3
Mean	2.22	2.67	2.56	3.67	3.22	3	2.89	3	3.22

6.2 Summary

The scores for each region for each stage of the analysis, and the overall scores, clearly indicate the potential for R&D to support integrated natural resource planning and management in the Ord/Bonaparte region (total score = 22.67, Table 27). The six next most favourable regions were (Victoria/Bonaparte, Western Cape York, southern Gulf of Carpentaria, Katherine/Daly–Bonaparte, Fitzroy/King Sound, and the Darwin Region) (total scores ranging from 14.79 to 18.32 – Table 27). The total scores for the Broome–Roebuck and North Kimberley regions were clearly lower than for other regions. The Ord/Bonaparte ranked highest on all major stages of the analysis, except from the MLA report (Roth *et al.*, 1998), where it was second highest.

Table 27. Total scores for each stage of the analysis for the selected regions

Region	MLA report (Roth <i>et al</i> 1998)	Environment, social & economic issues	Marine threats	Institutional issues	Capacity	R&D	Total	Overall rank
<i>Broome– Roebuck</i>	1	3	1.65	3.4	2.91	2.22	14.18	8
<i>Fitzroy– King Sound</i>	2	3.2	2.8	3.2	2.45	2.67	16.32	6
<i>North Kimberley</i>	1.5	2.5	1.75	2.8	2.18	2.56	13.29	9
<i>Ord– Bonaparte</i>	4	4.6	3.05	3.8	3.55	3.67	22.67	1
<i>Victoria– Bonaparte</i>	4.5	3.6	1.85	2.6	2.55	3.22	18.32	2
<i>Katherine Daly– Bonaparte</i>	2.5	3.9	2.15	2.6	2.82	3	16.97	5
<i>Darwin Region</i>	0.5	3.2	2.05	2.6	3.55	2.89	14.79	7
<i>Southern Gulf of Carpentaria</i>	3.5	4.2	2.1	2	2.27	3	17.07	4
<i>Western Cape York Peninsula</i>	3	3.9	2.1	2.6	2.64	3.22	17.46	3

The results presented in Table 27 indicate that the Ord–Bonaparte region in the Kimberley of Western Australia offers the greatest potential for future R&D aimed at supporting improved integrated resource planning and management. The Victoria–Bonaparte, Western Cape York, southern Gulf of Carpentaria, Katherine/Daly–Bonaparte, and Fitzroy–King Sound also have considerable potential. In the next chapter we outline a potential R&D response for the Ord–Bonaparte region.

7 Towards a R&D Response in Tropical Australia

7.1 Introduction

In Chapter 6 we concluded that Western Australia, and particularly the Kimberley region, would be the most suitable region for future R&D investment. There are two areas of the Kimberley where new R&D could successfully support sustainable natural resource use and management: the Fitzroy River–King Sound and the Ord River–Joseph Bonaparte Gulf. Both are attractive; however, we believe that the Ord–Bonaparte offers the greatest potential return for R&D investment.

7.2 Conceptual Approach for Future Research and Development

Currently, decisions on the sustainable use of natural resources in the Kimberley region are not integrated across the economy, ecology and society of the region (Figure 11). A more effective model is proposed to integrate and coordinate across these three groups of decision-makers (Figure 12).

Figure 11. The predominant model of decision-making on ecological sustainability in the Kimberley. It gives primacy to economic decisions and assumes that environmental problems can always be solved if the economy is sound. (Modified from: SEAC (1996), pp. 10–12.)

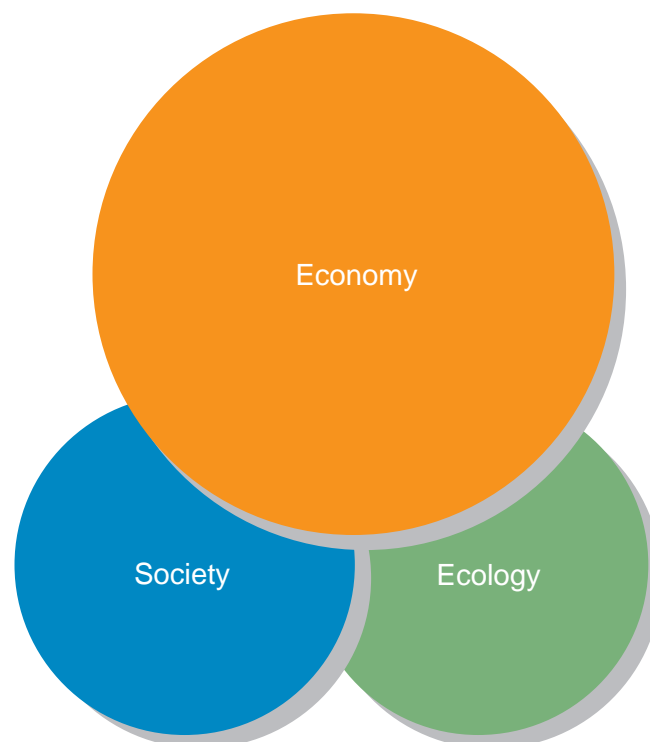
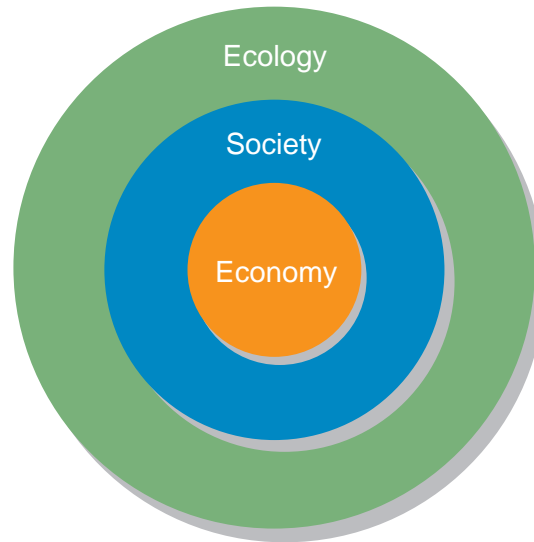
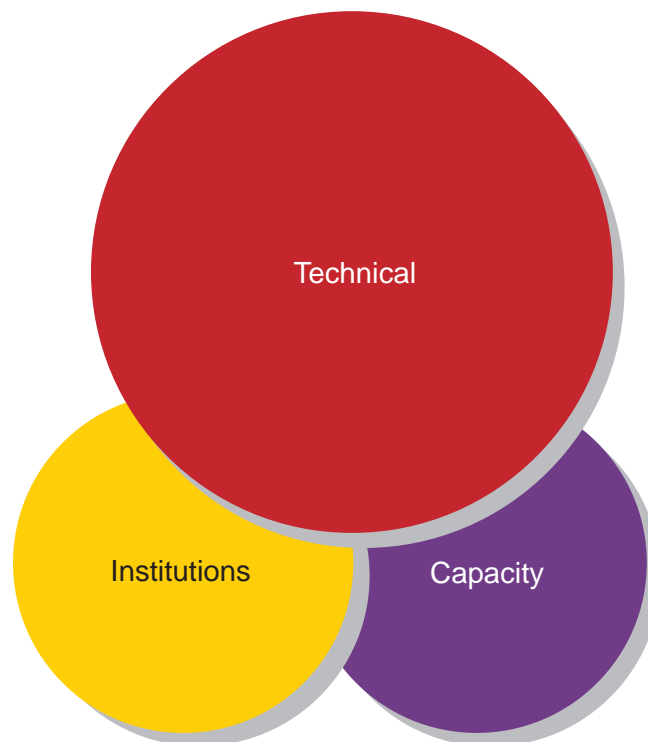


Figure 12. The suggested model for more effective decision-making to ensure ecologically sustainable development in the Kimberley region. It recognises that the economy is a subset of society, since many important aspects of society do not involve economic activity. Similarly, human society is constrained by the ecology of the region, ecology must therefore be integrated into all social and economic planning (Modified from: SEAC (1996), pp. 10–12.)



In the Kimberley, and specifically in the Ord River basin–Joseph Bonaparte Gulf region, there are substantial opportunities for R&D investment, co-investment and partnership. Typically, R&D providers work within an R&D framework, with little integration of research on technical, institutional and capacity issues (Figure 13).

Figure 13. The predominant model of R&D in natural resource planning and management in Australia.



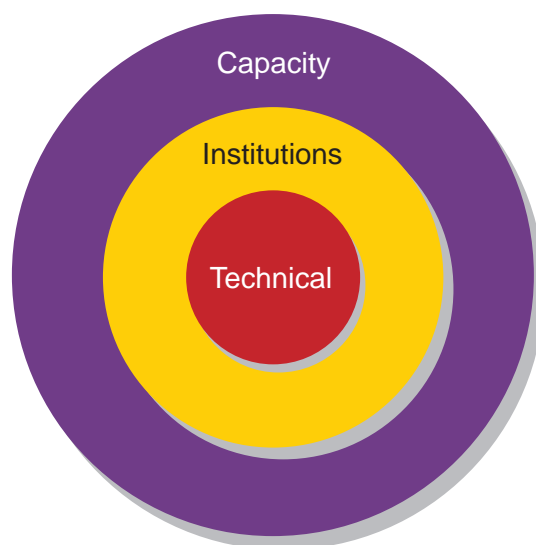
This model emphasises technical aspects, and focuses on biophysical rather than social or economic issues. In addition, capacity development is mainly confined to ‘linear’ technology transfer or project communications. This model is not suitable for the effective planning and management of sustainable natural-resource use.

We believe that a planning systems approach is the most appropriate and viable R&D model for the Kimberley region. The key principles of this model are:

- *Sustainability* – achievement of sustainable natural-resource use outcomes;
- *Equity* – in establishing structures and process within and between stakeholders;
- *Accountability* – within and between stakeholders, particularly between government and the community; and
- *Integration* – of scientific disciplines, processes and institutions.

The model is designed to result in effective institutions, improved stakeholder capacity and strong technical support (Figure 14). In contrast to the current model (Figure 13), this model emphasises issues relating to institutions and stakeholder capacity. The technical component is made up of biophysical, economic and social sub-components.

Figure 14. The suggested R&D model to support ecologically sustainable development in the Kimberley region. It recognises that technical information and knowledge, as well as institutional arrangements, support stakeholder’s capacity to undertake natural resource planning and management activities. Importantly, it recognises that much natural resource planning and management are often constrained by more than just technical issues and institutional factors.



Within a planning systems framework, participatory approaches to R&D offer the best opportunity for effective stakeholder involvement. However, they require scientific practice to be ‘opened up’, which raises serious issues for R&D agencies who must be willing and able to respond to the requirements of supporting participatory processes, as well as the results generated by those processes. Participatory approaches put R&D providers in a negotiating rather than a controlling role, even in areas they would normally consider the domain of science. Furthermore, it opens scientific assumptions and processes to scrutiny and questioning by non-scientists, which would change both the culture and management of science. Participation processes also lead to the formation of new partnerships.

Increasingly, R&D providers are using participatory approaches with non-traditional clients such as integrated catchment management groups, Indigenous groups or local government. However, moving beyond the traditional client bases requires an effort to build an understanding of common purpose and strategy, agreement on roles and responsibilities, define new operating principles and acceptable forms of behaviour, and develop agreed indicators or measures of performance. Hence, all the things that R&D providers generally take for

granted and that define and regulate their own behaviour would probably have to be re-negotiated with others whose perspectives and perceptions, beliefs and values may be very different from their own. Hence, R&D providers should expect to have more formal and lengthy discussions, analyses and negotiations with stakeholders over future R&D if we are to build a common vision for action in tropical Australia.

7.3 Strategic Research Objectives

From our discussions with stakeholders (Chapter 5) and our review of the literature (Chapters 2 to 4), we have developed strategic R&D objectives for the Ord/Bonaparte region (Tables 28 to 30). We have also identified potential stakeholders and research providers.

These objectives are meant to provide a basis for negotiation between R&D providers, research partners and stakeholders. The objectives are grouped according to the planning systems framework outlined in Chapter 2 (ie. Capacity, Institutions, and Technical). We have also identified strategies to achieve these objectives.

The time-lines and financial resources indicated in the tables are **estimates** only; as with the objectives, they would be developed further through discussions with stakeholders and research providers.

Twelve objectives were identified to improve the capacity of stakeholders in the planning and management of the sustainable use of natural resources. The studies to achieve these range in length from 6 months to 3 years. Five objectives were identified to assess the institutional arrangements in the area, and 18 technical objectives were developed.

Table 28. Potential strategic research objectives for the Kimberley Region – capacity.

#	Strategic research objective	Strategy to achieve research objective	Potential R&D partners	Potential contributing CSIRO Divisions	Estimated duration (yrs)	Estimated budget (\$'000/yr)
C1	Develop improved stakeholder analysis methodologies	Develop tools and or methods to better characterise and analyse stakeholders	WAPC, DRD, AgWA, WA WRC, WA C&T, KDC, KLC, SWEK	Tropical Agriculture Land & Water Marine Research Wildlife & Ecology Minerals	1	30
C2	Evaluate appropriate capacity development models	<ul style="list-style-type: none"> Review capacity-development methods adopted in national and international jurisdictions Develop flexible context-adaptive model 	CRC SDTS, UWA, CINCRM, NTU, AgWA, CALM, KLC, CINCRM	Tropical Agriculture Land & Water Marine Research Wildlife & Ecology	0.5	40
C3	Develop an improved understanding of how information technology in enhancing the capacity of clients and stakeholders to adopt R&D products	Evaluate the role of: <ul style="list-style-type: none"> facilitation in ensuring R&D delivery information technology in enhancing the capacity of stakeholders to adopt R&D products information technology tools such as simulation models, knowledge bases, expert systems and decision support systems to facilitate participatory learning traditional methods for experimentation, participatory conflict-resolution and negotiation 	WAPC, DRD, AgWA, WA WRC, WA C&T, KDC, KLC, SWEK, NTLPE, CRCSDTS	Tropical Agriculture Land & Water Marine Research Wildlife & Ecology	1	40
C4	Provide an improved basis for facilitating stakeholder access to data, information and knowledge	<ul style="list-style-type: none"> Develop tools and methods to facilitate information access and understanding in remote and widely dispersed communities Requires C1–3 	CRC SDTS, UWA, CINCRM, NTU, AgWA, CALM, KLC, NTLPE	Tropical Agriculture Land & Water Marine Research Wildlife & Ecology Maths & Info. Sciences	3	120
C5	Integrate systems methodologies into participatory approaches for natural resource planning and management	Develop tools and or methods to: <ul style="list-style-type: none"> facilitate inter-organisational collaboration to promote people-oriented R&D facilitate interaction between different levels of organisations in agricultural and natural resource systems where there are constraints to innovation and change monitor and evaluate the impact of participatory approaches to R&D enable scientists to critique their own practices and enter into dialogue with stakeholders 	WAPC, DRD, AgWA, WA WRC, WA C&T, KDC, KLC, SWEK	Tropical Agriculture Land & Water Marine Research Wildlife & Ecology Minerals	4	160
C6	Develop methods and tools for improving the effectiveness of education and extension for natural resource planning and management	<ul style="list-style-type: none"> Examine community education and development processes in the Kimberley region Formulate and evaluate appropriate methods and tools 	CRC SDTS, UWA, CINCRM, NTU, AgWA, CALM, KLC, CINCRM, NTLPE	Land & Water Tropical Agriculture Marine Research Wildlife & Ecology CSIRO HO Minerals	3	75

#	Strategic research objective	Strategy to achieve research objective	Potential R&D partners	Potential contributing CSIRO Divisions	Estimated duration (yrs)	Estimated budget (\$'000/yr)
C7	Evaluate integrated approaches to natural resource planning and management as a basis for inter-stakeholder negotiations in the Ord-Bonaparte region	<ul style="list-style-type: none"> Assess the cost-effectiveness of integrated and participatory approaches to planning and management Develop better mechanisms for stakeholders to identify and express values Design processes that admit a plurality of interests and promote interactive rather than autocratic solutions Design better tools to model negotiation processes Improve the use of knowledge bases by asking how decisions would be improved with specific improvements in information Explore non-Eurocentric models of negotiation for resource use Explore the potential application of regional planning to Indigenous land use agreements negotiated under <i>Native Title Act 1993</i> Use actor and arena models to plan negotiations and/or predict outcomes Requires C5 	WAPC, DRD, AgWA, WA WRC, WA C&T, KDC, KLC, SWEK, NTLPE, NTDFIF, NTPWC	Land & Water Tropical Agriculture Marine Research Wildlife & Ecology Minerals	4	120
C8	Develop improved tools and methods for monitoring and evaluation of the impact of participatory approaches to R&D	<ul style="list-style-type: none"> Develop mechanisms for maintaining regional planning support beyond plan production Explore the use of impact assessment in plan evaluation Develop methods to evaluate the effectiveness of R&D, especially in complex domains dealing with systems, multi-discipline, multi-agency and long term research 	WAPC, DRD, AgWA, WA WRC, WA C&T, KDC, KLC, SWEK, CINCRM	Tropical Agriculture Land and Water	5	75
C9	Ethical aspects of participative approaches, particularly within a community participation context	<ul style="list-style-type: none"> Methods to evaluate the ethics of participative approaches, particularly community participation Further adapt systems methodologies within a participatory framework Improved understanding of the appropriate balance between science push and client pull within a participatory framework Improved incorporation of culturally appropriate participation methodologies into resource management 	WAPC, DRD, AgWA, WA WRC, WA C&T, KDC, KLC, SWEK, CINCRM	Tropical Agriculture Land and Water	5	75

Table 29. Potential strategic research objectives for the Kimberley region – institutions.

#	Strategic research objective	Strategy to achieve research objective	Potential R&D partners	Potential contributing CSIRO Divisions	Estimated duration (yrs)	Estimated budget (\$'000/yr)
11	Develop an improved understanding of the institutional and associated arrangements that directly affect natural resource management in the region	<ul style="list-style-type: none"> Characterise current institutional arrangements and processes affecting natural resource management in the Kimberley Characterise the structural features of the institutions and interactions between them 	CRC SDTS, CAEPR, NARU, CINCRM, CRES, WAPC, NTLPE, NTDPIF, NTPWC	Tropical Agriculture Wildlife & Ecology Land & Water Marine Research Minerals	1	30
12	Develop an improved understanding of institutional processes and their influence/importance on decision-making within a regional context	<ul style="list-style-type: none"> Characterise the importance and/or influence of institutional processes on resource management in the Kimberley through development of robust criteria for assessing influence/importance of institutions and stakeholder capacity for institutional change Requires 11 	CRC SDTS, CAEPR, NARU, CINCRM, CRES, WAPC, NTLPE, NTDPIF, NTPWC	Tropical Agriculture Wildlife & Ecology Land & Water Marine Research	1	40
13	Assess the effectiveness of current institutional arrangements and processes from a social, political and technical perspective	<ul style="list-style-type: none"> Evaluate the effectiveness of current institutional arrangements and processes in the Kimberley region from a social, political and technical perspective via development of: <ul style="list-style-type: none"> robust criteria for use in assessment of institutions in natural resource planning and management tools and techniques for institutional analysis Requires 12 	CRC SDTS, CAEPR, NARU, CINCRM, CRES, WAPC, KLC, KDC, SWEK, AgWA, NTLPE, NTDPIF, NTPWC	Tropical Agriculture Wildlife & Ecology Land & Water Marine Research	3	65
14	Develop and evaluate alternative institutional arrangements and processes that will benefit a broad range of stakeholders	<ul style="list-style-type: none"> Develop and evaluate options for alternative institutional arrangements in the Ord–Bonaparte region Requires 13 	CRC SDTS, CAEPR, NARU, CINCRM, CRES, WAPC, KLC, KDC, SWEK, AgWA, NTLPE, NTDPIF, NTPWC	Tropical Agriculture Wildlife & Ecology Land & Water Marine Research	4	90
15	Develop an improved understanding of the organisational context of planning in the Kimberley and WA in general	<ul style="list-style-type: none"> Develop improved methods of organisational analysis Examine the role of the State in natural resource planning and management Developing and evaluating policies and organisational structures that have the capacity and flexibility to resolve cross and inter-sectoral resource use conflicts Develop a better understanding of inter-regional linkages in the Kimberley Explore natural resource planning and management to provide a context for action as well as research coordination 	WAPC, DRD, AgWA, WA WRC, WA C&T, KDC, KLC, SWEK	Tropical Agriculture Land & Water Marine Research Minerals	3	65

Table 30. Potential strategic research objectives in the Kimberley Region – Technical.

#	Strategic research objective	Strategy to achieve research objective	Potential R&D partners	Potential contributing CSIRO divisions	Estimated duration (yrs)	Estimated budget (\$'000/yr)
T1	Characterise catchments in the Joseph Bonaparte Gulf (NW WA/SW NT), in terms of their biophysical, social, cultural and economic resources	Develop innovative approaches to catchment classification, including rapid assessment techniques in data sparse environments that integrate across disciplines and local, catchment, regional and landscape scales	WA Fisheries, WA CALM, NTDPPIF, AFMA, NLC, KLC	Land and Water Tropical Agriculture Wildlife & Ecology Maths & Info. Sciences Minerals	2.5	45
T2	Characterise the estuaries, coasts and shallow continental shelf in the Joseph Bonaparte Gulf in terms of biophysical, social and economic resources	Develop innovative approaches to marine classification that include new coastal characterisation techniques and rapid assessment techniques in data sparse environments that integrate across scales and disciplines. Includes ground truthing of remote and rapid assessment techniques	WA Fisheries, WA CALM, NTDPPIF, AFMA, NLC, KLC	Marine Research Maths & Info. Sciences	3	250
T3	Develop a fundamental knowledge of processes and interactions between patterns and process of resource use activities at paddock, catchment and landscape scales in the Ord River catchment	<ul style="list-style-type: none"> • Delineate patterns of biodiversity at community, landscape and regional scale • Determine thresholds of land use associated with emergent problems • Develop methods to link plant community change to biological attributes • Define linkages between process at plant community, landscape and regional scale 	CALM, AgWA, KLC, CCRC SDTS, KAPA, WA PGA, NTLPE, NTDPPIF, NTPWC	Tropical Agriculture Wildlife & Ecology	3	120
T4	Quantify the impacts of land management practices on the ground and surface water resources of the Ord River catchment	<ul style="list-style-type: none"> • Characterise land use and management practices that impact water, sediment and nutrient export in the representative catchments • Develop innovative models to predict water, sediment and nutrient transport in representative tropical catchments and their fate in, and effects on, the marine environment of the Joseph Bonaparte Gulf. 	AgWA, WA CALM, OIC, WA WRC, WA Water Corp., KLC, SWEK, KAPA, CRC SDTS, DRD, WA PGA, NT LPE, NTDPPIF, Consultants.	Land & Water Tropical Agriculture Wildlife & Ecology Plant Industry Minerals	3	250
T5	Investigate the ecological impacts of land management practices in the Ord River catchment on aquatic resources	<ul style="list-style-type: none"> • Characterise the aquatic biology and ecology of the Ord River catchment • Develop ecological-effects models of impacts of Ord catchment derived water, sediment and nutrient on the biology and ecology of aquatic systems 	AgWA, WA CALM, OIC, WA WRC, WA Water Corp., KLC, SWEK, KAPA, CRC SDTS, WA PGA.	Land & Water Marine Research Minerals	4	120
T6	Investigate the impacts of land management practices on coastal and marine resources from the spatial and temporal distribution of water, sediment and nutrient export from the Ord River catchment	Develop models of impacts of water, sediment and nutrient from the Ord catchment on productivity of coastal habitats (eg. mangroves, seagrasses, fringing coral reefs and megabenthos)	AgWA, WA CALM, OIC, WA WRC, WA Water Corp., KLC, SWEK, WA Fisheries, KAPA, CRC SDTS, DRD, NTDPPIF, AFMA.	Land & Water Marine Research Minerals	3	250

#	Strategic research objective	Strategy to achieve research objective	Potential R&D partners	Potential contributing CSIRO Divisions	Estimated duration (yrs)	Estimated Budget (\$'000/yr)
T7	Quantify the impact of climate variability on the spatial and temporal distribution of water, sediment and nutrient from the Ord catchment and on future resource use	Develop models of climate variability in the Kimberley in order to assess the potential economic, ecological, social and cultural impacts of change on the Ord catchment and associated coastal environments of the Joseph Bonaparte Gulf	BoM, AgWA, WA CALM, OIC, KDC, WA WRC, WA Water Corp., KLC, SWEK, KAPA, CRC SDTS, Consultants.	Atmospheric Research Land & Water Tropical Agriculture Marine Research	3	200
T8	Develop an improved understanding of social, cultural and economic processes operating in the Kimberley	<ul style="list-style-type: none"> Improve knowledge of social/psychological values, perceptions needs and expectations Explore the nature of intra-regional social linkages Develop and enhance regional economic model for the Kimberley 	WA Fisheries, WA CALM, NTDPF, NTLPE, CINCRM, CRC SDTS, WA WRC, WA Water Corp., WA Tourism, WAPC, WA C&T	Tropical Agriculture Land & Water Marine Research Minerals	3	75
T9	Develop methods for improved integration of cultural heritage considerations in regional planning and management	<ul style="list-style-type: none"> Explore and develop ways to resource Indigenous groups to undertake their own cultural heritage assessment work as a basis for negotiation of resource use issues Exploring methods to more directly involve communities in identifying and preserving the culturally and socially important places and traditions within the region 	WA CALM, WAPC, NTDPF, NTLPE, CINCRM, KDC, KLC, CRC SDTS, WA WRC, WA Fisheries, WA Water Corp., WA Tourism, WA C&T, CINCRM	Tropical Agriculture Land & Water Marine Research Wildlife & Ecology Minerals	3	40
T10	Develop methods for improved integration of social considerations within natural resource planning and management in the Kimberley	<ul style="list-style-type: none"> Explore ways to translate social goals in regional plans into implementable strategies Develop clear performance criteria, which can be written into regional plans in ways that will influence land use decisions Better understanding the relationship between human service delivery, economic productivity and the adoption of sustainable management practices 	WA CALM, WAPC, NTDPF, NTLPE, CINCRM, KDC, KLC, CRC SDTS, WA WRC, WA Fisheries, WA Water Corp., WA Tourism, WA C&T, CINCRM	Tropical Agriculture Land & Water Marine Research Wildlife & Ecology Minerals	3	60
T11	Evaluate the aquaculture potential of the Kimberley region	<ul style="list-style-type: none"> Develop an assessment method that incorporates biophysical, cultural, economic and social factors Apply the method at catchment and regional scale 	WA Fisheries, WA CALM, NTDPF, WA C&T, WACC	Marine Research Land & Water Building, Const. & Engineering	2	120
T12	Quantify impacts of tourism development in the north Kimberley and Ord River catchment	<ul style="list-style-type: none"> Develop tourism impact assessment models that account for ecological, social, cultural and economic factors Develop methods for the integration of tourism issues into mainstream natural resource planning and management activities at the catchment and regional level in the Kimberley 	KDC, WA CALM, , KLC, Tourism CRC SWEK, KAPA, CRC SDTS, WA Transp., WA C&T, WACC, WA Tourism, WAPC, WA Fish., WA WRC	Wildlife & Ecology Building, Const. & Engineering Maths & Info. Sciences	3	185

#	Strategic research objective	Strategy to achieve research objective	Potential R&D partners	Potential contributing CSIRO Divisions	Estimated duration (yrs)	Estimated budget (\$'000/yr)
T13	Develop indicators of regional and catchment sustainability in the Ord–Bonaparte region	<ul style="list-style-type: none"> Define, in partnership with stakeholders, catchment/regional indicators of: <ul style="list-style-type: none"> land condition and river health indicators marine health indicators economic, social and cultural indicators 	CRC SDTS, WA CALM, KDC, KLC, WAPC, WA WRC, WA Fisheries, WA Water Corp., WA Tourism, WA C&T, CINCRM, WACC, NTLPE, NTDPPIF, NTPWC	Tropical Agriculture Wildlife & Ecology Land & Water Marine Research	3	120
T14	Methods and strategies for integrating economic, ecological, cultural and social values into agricultural and pastoral production systems in the Kimberley	<ul style="list-style-type: none"> Develop management methods and strategies for integrating resource management/conservation and cultural/heritage values into agricultural and pastoral production systems in the Ord River catchment Identify criteria for evaluation Evaluate methods and strategies with stakeholders for their relevance to other parts of the Kimberley and tropical Australia 	WA CALM, KLC, WAPC, CRC SDTS, WA WRC, WA Fisheries, WA Water Corp., WA Tourism, WA C&T, CINCRM, Environs Kimberley, OIC, WACC	Tropical Agriculture Wildlife & Ecology Land & Water Plant Industry	3–4	80
T15	Identify options for satisfying future transport and infrastructure requirements for the Kimberley	<ul style="list-style-type: none"> Develop cost effective and ecologically sustainable methods and approaches for improved transport planning Develop stakeholder generated transport plans to underpin negotiation over existing/future planning and management 	KDC, SWEK, KLC, AgWA, NT & WA Transport, WA Mines & Energy, DRD, WA Tourism, WAPC, WA C&T, OIC, NTLPE, NTDPPIF, NTPWC	Building, Const. & Engineering Wildlife & Ecology Maths & Info. Sciences	3	110
T16	Define and develop appropriate system synthesis and integration tools for planning and management of resource use in the Ord–Bonaparte region	<ul style="list-style-type: none"> Development of appropriate tools and methods for decision support to integrate and deliver the results of the biophysical and socio-economic research to underpin negotiated approaches Evaluate their usefulness for other parts of tropical Australia 	KDC, KLC, AgWA, CALM, WA WRC, WAPC, WA C&T, WA Fisheries, WACC, NTDPPIF, NTLPE	Tropical Agriculture Wildlife & Ecology Marine Research Maths & Info. Sciences	3	130
T17	Assess trade-offs between multiple objectives and multiple stakeholders for resource use in the Ord–Bonaparte region	<ul style="list-style-type: none"> Methods and processes for assessing trade-offs between multiple objectives and multiple players, and planning regional resource use Methods/strategies to facilitate integration of multiple land use and objectives at catchment and regional scales Processes to facilitate equitable resource use outcomes, particularly in regard to Indigenous stakeholders 	KDC, KLC, WAPC, WA WRC, NT & WA Fisheries, WA Water Corp., WA Tourism, WA C&T, CINCRM, Environs Kimberley, SWEK, WACC, NT & WA Transport, WA CALM, OIC, NTLPE	Tropical Agriculture Wildlife & Ecology Marine Research Building, Const. & Engineering Land & Water Maths & Info. Sciences Minerals	3	120
T18	Develop improved methods for natural resource planning and management in the Kimberley	<ul style="list-style-type: none"> Utilising the outputs/outcomes of C6 and T1–17 Develop/foster mechanisms to facilitate the implementation of frameworks, methods, processes to underpin planning at the regional scale in the Kimberley and where appropriate, to other parts of tropical Australia 	KDC, KLC, WAPC, AgWA, CALM, WA Fisheries, WA WRC, CINCRM, WA C&T, WACC, NTLPE, NTDPPIF	Tropical Agriculture Wildlife & Ecology Land & Water Marine Research	4	75

7.4 Integrated R&D Proposals

The strategic research objectives outlined in Tables 28 to 30 can be grouped into seven integrated R&D proposals, incorporating strategic research objectives for stakeholder capacity, institutional arrangements and technical information.

1. Improved natural resource planning and management capacity in the Kimberley region

This R&D would focus on assisting stakeholders in the Kimberley region to improve their capacity to participate in natural resource planning and management. The expected main outputs and outcomes would include:

- methods that improve the planning capacity within Kimberley stakeholder groups;
- improved structures for the negotiation of existing and/or potential conflicts over land use and management in the region; and
- tools, methods and processes that enable Kimberley stakeholders to access, integrate and use outputs from a range of sources in their planning activities.

2. Improved institutional arrangements for natural resource management and planning in the Kimberley region

This R&D would aim to assess the current institutional arrangements influencing natural resource planning and management in the Kimberley, identifying their strengths and weaknesses, and developing and evaluating alternatives where necessary. The expected outputs and outcomes would include:

- characterisation of the institutional environment and associated arrangements that directly affect natural resource planning and management in Kimberley;
- an evaluation of the structural features of those institutions and interactions between them, including processes and their influence/importance on decisions and decision-making;
- an evaluation of the effectiveness of current institutional arrangements and process from a social, political and technical perspective; and
- where appropriate, propose alternatives and processes for the region.

3. Assessment of impacts of natural resource use on ground and surface waters of the Ord River catchment

R&D would focus on the impacts of resource use on sediment generation, nutrient movement, water flow and other contaminant flux of ground and surface waters at scales ranging from farm to catchment. The following would be among the anticipated outputs and outcomes.

- Tools, techniques and methods for:
 - rapid biodiversity assessment and monitoring;
 - innovative spatial analysis methods for data sparse regions incorporating statistical estimates of uncertainty;
 - predictive capability for estimating movement of biophysical materials in the tropics;
 - predictive capability for estimating fate/effect of biophysical materials in terrestrial and aquatic systems;
 - image and acoustic methods for remote resource assessment and monitoring; and
 - improved economic analysis incorporating private/public costs/benefits associated with resource development.
- Innovative mechanisms/processes to ensure R&D delivery to stakeholders and clients, based on the development of active partnership and focused on the operational implementation of research products.
- An innovative, toolkit-based approach to decision support that integrates existing information and technology (eg. GIS, remote sensing, models) as well as the products of the new research outputs from this project, especially the improved understanding of the terrestrial/aquatic interface.

4. Assessment of impacts of natural resource use in the Ord River catchment on the marine resources of the Joseph Bonaparte Gulf

This work would focus on the impacts of resource use on the adjacent marine environment in terms of sediment, nutrient, water and other contaminant fluxes from ground and surface waters at catchment. The expected outputs and outcomes would include the following:

- Tools, techniques and methods for:
 - rapid biodiversity assessment and monitoring;
 - innovative spatial analysis methods for data sparse regions incorporating statistical estimates of uncertainty;
 - predictive capability for estimating movement of biophysical materials in the tropical marine systems;
 - predictive capability for estimating fate/effect of biophysical materials in marine systems;
 - image and acoustic methods for remote resource assessment and monitoring in marine environments; and
 - improved economic analysis incorporating private & public costs/benefits to marine systems associated with resource development.
- Innovative mechanisms/processes to ensure R&D delivery to stakeholders and clients, based on the development of active partnerships and focused on the operational implementation of research products.
- An innovative, toolkit-based approach to decision support that integrates existing information and technology as well as the products of the new research outputs from this project, especially the improved understanding of the terrestrial/marine interface.

5. Sustainable development of the Kimberley: R&D for integrated planning and management of land, water and marine resources in the Ord–Bonaparte region

This would be a major R&D effort aimed at integrating current and new knowledge to support the development and implementation of negotiated approaches to natural resource planning and management. Anticipated outputs and outcomes would include:

- A substantial increase in fundamental and baseline biophysical and socio-economic knowledge to support improved natural resource planning and management.
- Tools, techniques and methods for:
 - new, accurate, cost-effective rapid biodiversity assessment and monitoring;
 - innovative spatial analysis methods for data poor areas incorporating statistical estimates of uncertainty;
 - predictive capability for estimating movement of biophysical materials in the tropics;
 - predictive capability for estimating fate/effect of biophysical materials in tropical aquatic and marine systems;
 - new and improved image and acoustic methods for remote resource assessment and monitoring;
 - improved economic analysis incorporating private/public costs/benefits associated with resource development;
 - assessing the impacts of climate change and variability;
 - the potential for aquaculture development;
 - more efficient transport planning and assessing the impacts of tourism development; and
 - improved natural resource planning approaches at a regional scale.
- Innovative mechanisms/processes to ensure R&D delivery to stakeholders and clients, based on the development of active partnership with clients and stakeholders and focused on the operational implementation of research products.
- An innovative, toolkit-based approach to decision support to underpin sustainable natural resource policy, planning and management, that integrates existing information and technology (eg. GIS, remote sensing, models) as well as the products of the new research outputs from this project, especially the improved understanding of the terrestrial/aquatic/marine interface
- Synthesis and integration, within a systems framework, of biophysical and socio-economic research to underpin improved development and analysis of policy, planning and management.
- A significant contribution to ensure the ecologically sustainable development of multiple resource uses in northern Australia. If successful, the approach could be readily transported to other rapidly developing regions in northern Australia (eg. Fitzroy River, QLD, WA) and South-East Asia.

In addition, two other options worthy of consideration, but of lower immediate priority are:

(a) Climate variability in the Kimberley region: impacts and options for the Ord–Bonaparte region

R&D would be conducted to assess the social, economic and biophysical impacts of climate variability in the Kimberley. Anticipated outputs and outcomes would include:

- tools linking models of the atmosphere, biosphere, and oceans to examine the climate of the Kimberley region;
- accurate seasonal prediction schemes for the Kimberley region;
- scenarios and assessments of likely climate changes for use as key inputs for impact studies;
- tools to assess the biophysical, economic and social impact of climate change and variability; and
- decision-support systems to provide planners and managers with better climate information and risk management principles.

(b) Sustainable development of Kimberley tourism: impacts and options for the north and east Kimberley

This would focus on assessing the potential social, economic and biophysical impacts of tourism development in the Kimberley. The expected outputs and outcomes would include:

- planning and management framework for tourism developments;
- methods to better integrate tourism into regional planning;
- tools and methods to evaluating future choices for tourism in the Kimberley;
- spatial models for planning environmental requirements and impacts of coastal tourism;
- planning and management guidelines for determining the physical and built environment impacts of tourism development;
- a framework for evaluating the benefits and impacts of nature-based tourism;
- methods for assessing tourism potential for the Kimberley; and
- tools and methods for integrating tourism with farming enterprises.

Table 31 describes the relationship between these research objectives and their component strategic research objectives.

Table 31. Relationship between R&D proposals and strategic research objectives.

Proposal #	Proposed title	Key research objectives
RP1	Improved natural resource planning and management capacity in the Kimberley region	Capacity: 1–9
RP2	Improved institutional arrangements for natural resource management and planning in the Kimberley region	Capacity: 1,3 Institutions: 1–5
RP3	Assessment of impacts of natural resource use on ground and surface waters of the Ord River catchment	Capacity: 1–6 Institutions: 1, 2, 5 Technical: 1, 3–5, 8, 14, 16, 17
RP4	Assessment of impacts of natural resource use in the Ord River catchment on the marine resource of the Joseph Bonaparte Gulf	Capacity: 1–6 Institutions: 1, 2, 5 Technical: 1–6, 8, 14, 16, 17
RP5	Sustainable Development of the Kimberley: R&D for integrated planning and management of land water and marine resources in the Ord–Bonaparte region	Capacity: 1–9 Institutions: 1–5 Technical: 1–18
RPA	Climate variability in the Kimberley region: impacts and options for the Ord–Bonaparte region	Capacity: 1–6, Institutions: 1,2,5 Technical: 7, 8, 14, 16, 17
RPB	Sustainable development of Kimberley tourism: impacts and options for the north and east Kimberley	Capacity: 1–6 Institutions: 1,2,5 Technical: 8, 12, 14, 16, 17

7.5 Models for R&D Management

Faced with the large range of research opportunities and options for stakeholder participation, a key question is: which would be the most appropriate R&D management model(s) to use? Given the complexity of the R&D options, models for more traditional, single disciplinary or single issue R&D (eg. Renn *et al.*, 1995) are not suitable. However, for natural resource planning and management activities, there are significant gaps both in theory and practice as to what constitutes an effective model for the management of R&D.

We briefly introduce six models for management of large, integrated R&D studies. Management is an important component of any research program, particularly those that support the sustainable use of natural resources. Five models are drawn from existing or proposed multidisciplinary R&D activities in natural resource planning and management. After describing the models, we evaluate them using eight *State principles* and six *Process principles* (see below) and assess the appropriateness of each management model for the seven research initiatives outlined in the previous section.

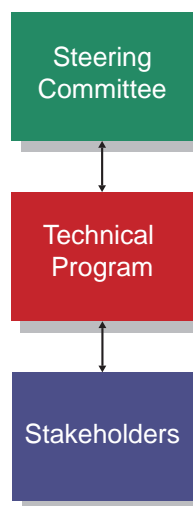
R&D Management Model 12 – Southern Metropolitan (Perth) Coastal Waters Study

The Southern Metropolitan (Perth) Coastal Waters Study was set up in 1991 by the Environmental Protection Authority of WA (completed in 1994) to address increasing threats to the environmental quality of the coastal waters from Fremantle to Mandurah. It focused on waste discharge—both its current impact and the long-term ecological consequences of projected discharges. The study developed environmental quality objectives, made inventory, baseline, and process studies, and defined and modelled environmental problems and solutions. The study sought community input principally by providing formal opportunities for:

- comment by key stakeholders on EPA discussion papers;
- community and stakeholder comment on project reports and discussion papers;
- invited technical input to an Environmental Quality Criteria discussion paper; and
- development of an information base.

The model used for the study is illustrated in Figure 15.

Figure 15. R&D Management Model 1 – Southern Metropolitan (Perth) Coastal Waters Study.



R&D Management Model 2 – Central Highlands Regional Resource Use Planning Study

The Central Highlands Regional Resource Use Planning Project, initiated by CSIRO Tropical Agriculture in 1997, was designed to resolve limitations in regional planning in rangeland environments. Following negotiations with regional stakeholder groups, this project sought to improve the sustainability and equity of resource management in the region by:

- providing support to assist regionally-focused resource use planning by regional groups with a stake in the region's resources and facilitate greater interaction among them; and

- using these support services to underpin research into developing and applying better processes, methods and techniques for regional resource use planning in rangelands.

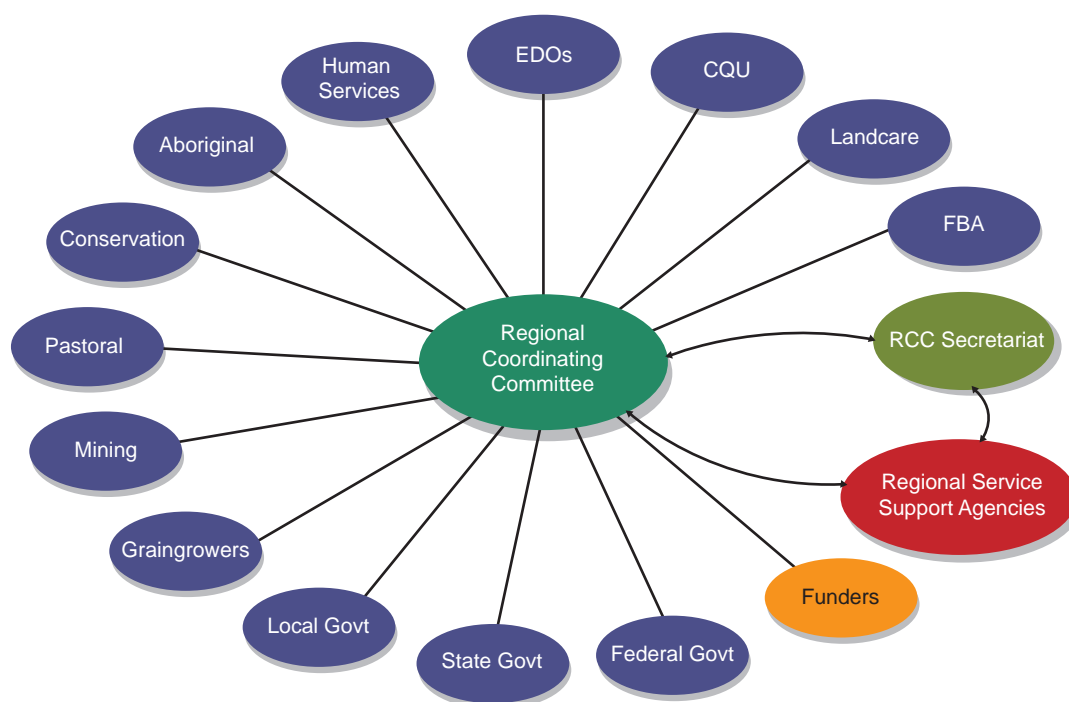
The research aims to define and assess existing regional resource-use planning in the Central Highlands, and to evaluate the ability of regional planning innovations to achieve more sustainable and equitable resource use outcomes. There are three core functions involved in the study:

- (i) the ‘planning function’ of regional sector groups and the newly formed Regional Coordination Committee;
- (ii) the ‘support function’ of CSIRO, key State and Federal agencies and the Central Queensland University; and
- (iii) the ‘research, development and evaluation function’ which examines the overall impact of the project’s approach and the specific techniques used.

Most of the project revolves around the regional planning activities of the regional sector groups. They identify strategic issues and resolve issues of regional sustainability. There is also a focus on self-evaluation of the effectiveness of the research within regional sector groups and the development of parallel strategies to improve their capacity to plan.

The research was supported by the early establishment and regular monitoring of regional performance criteria for sustainable resource use, as well as criteria for different resource use groups to assess their regional planning activities. A framework for comparing regional planning in other rangeland regions and groups in Queensland, NSW and WA will also be developed. The project will be completed in 2002.

Figure 16. R&D Management Model 2 – Central Highlands Regional Resource Use Planning Project.



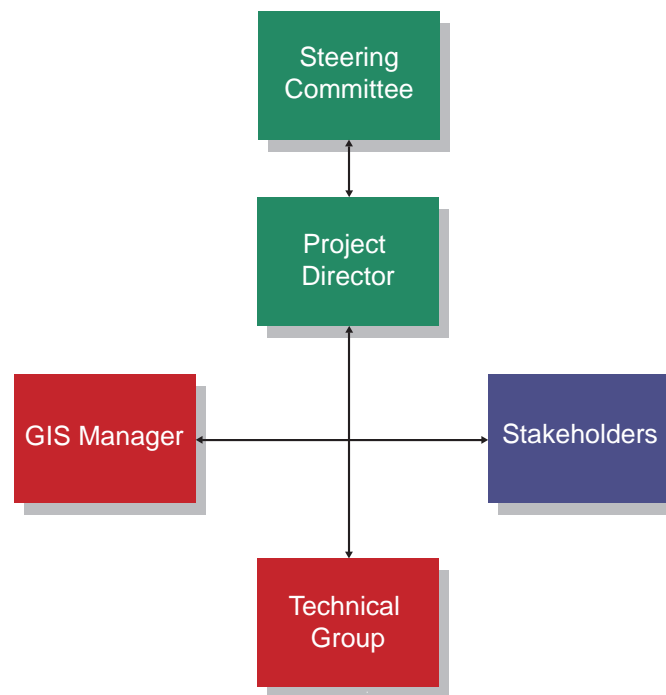
R&D Management Model 3 – North West Shelf Marine Environmental Management Study

In recognition of development pressures on the poorly understood marine environments of the North West Shelf, the West Australian Government has funded a North West Shelf Marine Environmental Management Study to provide impetus for a marine environmental management study of the region (DEP, 1998). Its aims are to develop and consolidate the technical information base, scientific understanding and predictive capability for environmental decision-making in both the private and public sectors. The study will concentrate on providing information of most strategic value for long-term sustainable use and conservation management in the region. The study aims to draw on the support and involvement of the science, industry, community and government agency (local, State and Federal) sectors. The management model is illustrated in Figure 17.

The study's steering committee, which includes representatives from State and Commonwealth government departments, industry and universities, is chaired by the CEO of the Western Australia Department of Environmental Protection. One of the committee's main tasks is to consult with its member organisations to determine the key issues and to set priorities. Representatives from government agencies will advise on environmental and natural resource policies, plans and management systems.

A technical group of seven scientists from several disciplines and agencies will assist the project director with the technical and management aspects of the study. To build up the information base the Technical Group will identify existing and planned research and environmental assessments. From the documentation available it is not yet clear how relationships with users will be developed and maintained.

Figure 17. R&D Management Model 3 – North West Shelf Marine Environmental Management Study.



R&D Management Model 4 – Catchment Management, Water Quality and Nutrient Flows in the Northern Beef Industry Study

After reviewing information on the effects of grazing management in northern Australia on water and nutrient cycles and the downstream fluxes of water, sediment and nutrients (Hook, 1997), the Northern Australia Plan 3 Program of Meat and Livestock Australia (formerly the Meat Research Corporation) commissioned a scoping study (Roth *et al.*, 1998) to:

- collate and review information on research projects studying water quality and nutrient flow issues that relate to grazing management in northern Australia, and to identify priorities for research;
- assess the relative vulnerability of grazed catchments across northern Australia and evaluate perceived risks to water quality and nutrient flows; and
- recommend focus catchments for research into grazing effects on catchments, and optimum implementation through a major multi-agency research group.

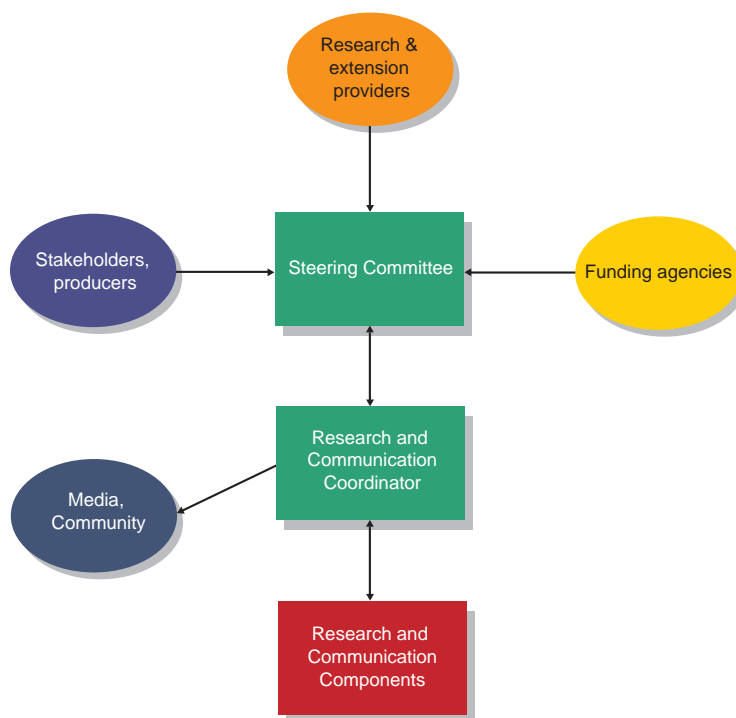
Considering the complexity, longevity and costs of a major project to research grazing management impacts on sediment and nutrient export, Roth *et al.* (1998) recommend that:

- the project focus around critical research components addressing the above two sets of priority issues;
- the research components be complemented by an effective communication strategy;

- the research components be designed to maximise links to existing research, particularly that into off-site impacts and the socio-economic determinants of grazing management; and
- the project be managed through a steering committee in liaison with a project coordinator responsible for research and communication coordination.

The management model is illustrated in Figure 18.

Figure 18. R&D Management Model 4 – Catchment Management, Water Quality and Nutrient Flows in the Northern Beef Industry Study.



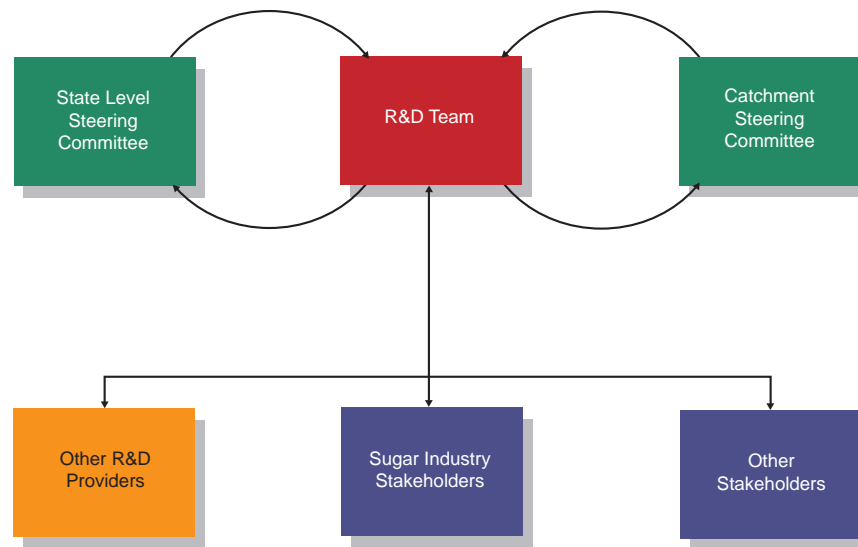
R&D Management Model 5 – Improved Integrated Resource Management in the Queensland Sugar Industry Study

In late 1996, a research project to develop and test methods for evaluating environmental and economic impacts of changes in land use and related infrastructure development in the Queensland sugar industry was initiated by the CRC for Sustainable Sugar Production. The study is designed to integrate socio-economic and biophysical methods for the economic–environmental analysis of current and prospective land-use systems.

A two-tier approach to R&D management in this project has been developed, through the formation of two functional groups (Figure 19). Mechanisms, processes and structures have been established to facilitate the involvement of other researchers, government decision-makers, resource users, land managers and extension agencies in the ongoing process of the project and in the technology transfer and application of results. Government, industry and the community are formally represented.

This approach requires continuous involvement with stakeholders. The transfer of technology and communication activities, through the continuous involvement and collaboration of stakeholders in planning, design of activities and implementation of outcomes are embedded in the study’s objectives. While most of interactions are informal or semi-structured, meetings and workshops are held regularly with all stakeholder groups to communicate progress and outcomes and get feedback. The study team liaises closely with local stakeholders and the media. A web-based regional information service is also facilitating access by a broad range of stakeholders to project activities and outcomes.

Figure 19. R&D Management Model 5 – Improved Integrated Resource Management in the Queensland Sugar Industry Study (QSIIS).



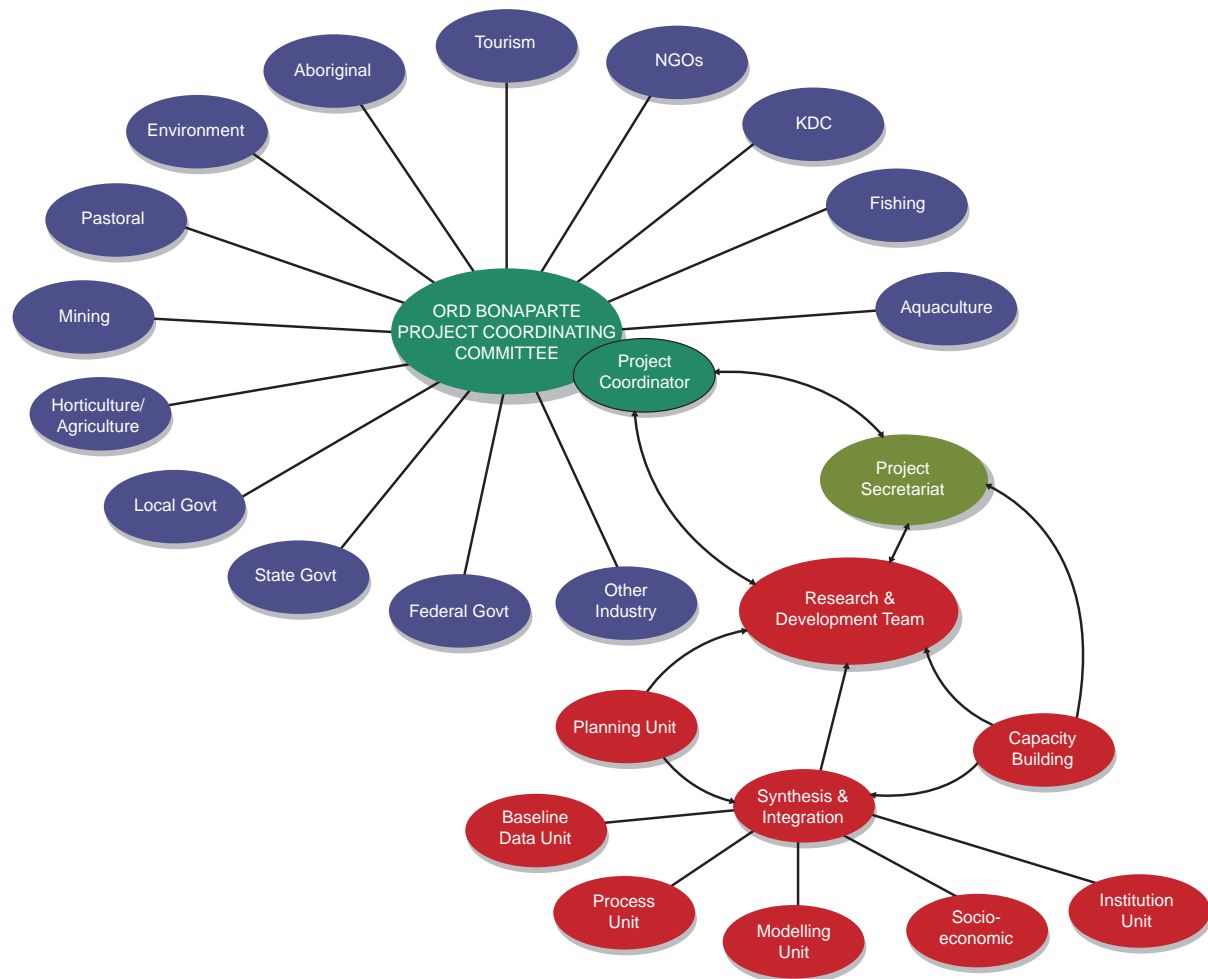
R&D Management Model 6 – Sustainable Development of the Kimberley Region: R&D for Integrated Planning and Management of Land, Water and Marine Resources Study (new model)

This R&D management model is proposed as an alternative to those presented previously. It draws on positive components of the other five models, particularly models 2 and 3. Its key features are:

- the broad range of stakeholders represented on a project coordinating committee;
- a specific and adequately resourced secretariat responsible for day-to-day project support, communication, liaison and information dissemination;
- a project director to provide overall leadership, direction and coordination to the R&D Team, as well as interact at a senior level with stakeholders. The project director would also be a member of the project coordinating committee;
- five core scientific research units;
- a core systems synthesis and integration unit;
- a core capacity building unit; and
- a core planning systems unit informed and underpinned by the other seven units.

While this model is potentially best suited to a major multi-disciplinary, multi-objective study, its core components have relevance to less complex contexts.

Figure 20. R&D Management Model 6 – Sustainable Development of the Kimberley Region: R&D for Integrated Planning and Management of Land, Water and Marine Resources Study (new model).



7.5.1 Evaluating Model Alternatives

The multi-dimensional nature of natural resource planning and management poses a challenge to R&D providers in the way in which R&D Projects are structured and managed. Drawing on the literature in management science (eg. Renn *et al.*, 1995) a number of overarching principles can be used to assess the potential suitability of management models for R&D supporting integrated resource management. These principles can be classified as ‘state principles’ which focus on structural attributes of managing research and ‘process principles’ which focus on process-related attributes (Renn *et al.*, 1995).

Eight state principles have been defined:

- *efficiency*: concerned with the relationship between inputs and outputs, this principle recognises that effective outcomes should not be considered in isolation of their cost;
- *adequacy*: the technical, negotiatory and participative elements of multi-disciplinary R&D that ensure their sufficiency in meeting the needs of the task, activity or process at hand;
- *adaptability*: the capacity of the R&D model to make strategic and operational change as changing circumstances and knowledge present themselves;
- *stability*: the capacity of the model to prevail under radically changed circumstances or through the unanticipated withdrawal of key participants or resource—a measure of model risk;
- *legitimacy*: the degree to which stakeholders and other formal participants represent the interests of those whom they are meant to represent;

- *accountability*: the need for the R&D team to be accountable to the stakeholders who have a legitimate role to play in the conduct of the R&D;
- *technical capacity*: the degree to which an appropriate balance is provided within and between contributing disciplines; and
- *equity*: the concepts of equity and fairness need to underpin the establishment of the R&D structures and processes for negotiation among stakeholders and the project team, as well as participatory approaches within stakeholder groups.

Six process principle have been defined:

- *effectiveness*: the need for the R&D to lead to meaningful and substantive outcomes in a timely manner;
- *collaborative*: recognition that no single R&D provider can call on all of the skills and expertise that may be required—measures the degree to which the model structure promotes and allows for effective collaboration; the degree to which the model promotes high level interaction amongst stakeholders;
- *participative*: the degree to which the model allows a high level of participation and involvement of stakeholder in the R&D process and promotes/facilitates consensual decision-making;
- *equitable*: measures the extent to which the domain of relevant stakeholders are represented;
- *evaluative*: the extent to which the model allows impacts and outcomes to be assessed widely; the extent to which the R&D model enables evaluation of process as well as product, and allows feedback of evaluation results to both the R&D team and participating stakeholders; and
- *integrative*: this principle addresses the degree to which the model supports a comprehensive approach to R&D that takes into consideration all view points across disciplines, processes and institutional arrangements.

An effective strategy for evaluating the suggested R&D models needs to draw on these principles. The six models of research management were assessed (Table 32) and their application to each of the seven major research initiatives evaluated. For research proposals 1 and 2 the management models for the North West Shelf or the Queensland Sugar Industry Study are likely to be most effective (Table 33). For research proposals 3 and 4 that both examine impacts of changes in natural resource use, the management model suggested for the Northern Beef Industry might be most appropriate, while the Integrated proposal in 5, would require a broader management model such as that suggested in the new model.

Table 32. Qualitative assessment of the relative ranking of each of the R&D models.

Criteria	Model 1 SMCWS	Model 2 CHRRUPP	Model 3 NWSME–MS	Model 4 NBIS	Model 5 QSI	Model 6 New
<i>State principles</i>						
Efficiency	High	Medium	High	High	High	Low
Adequacy	Medium	High	High	Medium	Medium	High
Adaptability	Low	High	Low	Medium	Medium	High
Stability	High	Medium	High	High	Medium	Medium
Legitimacy	Low	High	Medium	Medium	High	High
Accountability	High	High	High	High	High	High
Technical capacity	High	Medium	High	High	High	High
Equity	Low	High	Medium	High	High	High
<i>Process principles</i>						
Effectiveness	High	Medium	High	Medium	Medium	High
Collaborative	Medium	High	Medium	High	High	High
Participative	Low	High	Medium	Medium	High	High
Equitable	Low	High	Medium	Medium	Medium	High
Evaluative	Medium	High	Medium	Low	High	High
Integrative	Medium	High	Medium	Medium	High	High

Note: SMCWS = Southern Metropolitan Coastal Waters Study; CHRRUPP – Central Highland Regional Resource Use Planning Project; NWSEMS – North West Shelf Environmental Management Study; NBIS – Northern Beef Industry Study; QSI – Queensland Sugar Industry Study; New – New Model.

Table 33. Suggested R&D management models for each of the recommended major research proposals.

Proposal #	Proposed Title	R&D Model
RP1	Improving natural resource planning and management capacity in the Kimberley region	NWSEMS (3) or QGIS (5)
RP2	Improving institutional arrangements for natural resource management and planning in the Kimberley region	NWSEMS (3) or QGIS (5)
RP3	Impacts of natural resource use on ground and surface waters of the Ord River catchment	NBIS (4)
RP4	Impacts of natural resource use in the Ord River catchment on the marine resource of the Joseph Bonaparte Gulf	NBIS (4)
RP5	Sustainable Development of the Kimberley: R&D for integrated planning and management of land water and marine resources in the Ord–Bonaparte region	New (6)
RPA	Climate variability in the Kimberley region: impacts and options for the Ord–Bonaparte region	NBIS (4)
RPB	Sustainable development of Kimberley tourism: impacts and options for the north and east Kimberley	New (6)

Note: NWSEMS – North West Shelf Environmental Management Study (Model 3); NBIS – Northern Beef Industry Study (Model 4); QGIS – Queensland Sugar Industry Study (Model 5); New – New Model (Model 6).

It is important to note that none of the models perfectly meet all the criteria to address tensions between the legitimate demands for stakeholder participation, the need for technical and economic rigour, and the necessity for assuring accountability and responsibility of decision-making bodies. We recognise that fair and competent participation in the R&D process by both stakeholders and the R&D team(s) themselves will not eventuate through rigid application of these models, but by creatively and innovatively tailoring the models to be responsive to the problem setting. Indeed, there are opportunities to improve on these models and such activities that seek to combine technical expertise and rational decision-making with public values and preferences should be encouraged.

7.6 Summary

In this chapter we have drawn on material presented in preceding chapters to develop a range of strategic research objectives for the Kimberley region. These strategic research objectives were then synthesised into seven research proposals. In Chapter 8 we prioritise these proposals and recommend the steps for their implementation.

8 Conclusions and Recommendations

In this chapter, we synthesise the information from the preceding chapters and propose nine recommendations on developing an integrated program of R&D for the planning and management of the sustainable use of natural resources in tropical Australia. We also highlight some non-R&D issues for further consideration.

8.1 Publication of the Scoping Study Report

This study is unique in terms of: its integrated consideration of terrestrial and marine natural resources; its incorporation of not only technical issues for research, but also issues of institutional effectiveness and capacity development; its approach in terms of broad literature review and wide consultation of stakeholders; its incorporation of Indigenous issues; and its identification of a region and recommendations on priorities for research and development in that region. There have been a number of reports that have addressed each or combinations of these (eg. ASTEC, 1993; RAC, 1993; IC, 1997). Feedback from stakeholders in the study regions strongly supports our view that the material contained in this report has value as a reference for future work.

Recommendation 1: LWRRDC and FRDC publish the results of the Scoping Study as a LWRRDC Occasional Paper.

8.2 Scale of R&D

There are increasing demands for integrated and regional approaches to natural resource use planning and management. While these calls have emerged from Commonwealth and State government agencies, industry sectors and other stakeholder groups, there is a wide divergence of views about how this may be achieved. Some of these political demands are clearly and unambiguously articulated (eg. see the National Rangelands Strategy, Industry Commission (NRMWG, 1996; IC, 1997)). Others are more vaguely articulated in general policy statements supporting moves towards sustainability principles and practices (eg. environmental policies developed in the mining industry). Whether clear or ambiguous, most agencies, sectors, stakeholder groups and even academic institutions remain unclear about what sustainability entails, and how the concept can be applied effectively in a regional context. A significant opportunity exists in establishing systems of resource use planning and management that can deliver on the political rhetoric.

If integrated resource management is to match the political and theoretical rhetoric that underpins it, R&D must focus on better conceptualising sustainability at the regional level. This will require equitable negotiations among stakeholders aimed at reaching consensus on what a sustainable region actually constitutes (eg. what constitutes an adequate and representative reserve system, what are equitable resource allocations, what resource use practices do not constitute sustainable production, what indicators should be used to monitor sustainability). This requires a strong R&D emphasis on working towards regionally acceptable characterisations of sustainability (Dale and Bellamy, 1998).

While regional aspects of sustainability remain poorly defined, there are also important questions to be addressed regarding what it is regional approaches to resource use planning can deliver in addition to integrated catchment management and existing local scale activities (eg. Ribbons of Blue, Landcare, Future Profit and Property Management Planning). In practice, the mechanisms and linkages required to ensure effective inter-relationships among local and regional scales remain unclear. We suggest that, in theory, a two-way flow of benefits between regional to local levels can and must be achieved. In response, specific research is needed to determine the most effective ways of linking resource use planning and management processes at different scales (eg. from regional to catchment to property level)—the so-called planning systems approach. Research into regional approaches should not be at the expense of and in isolation from, continuing improvements in planning and management at these other scales and should identify ways to complement rather than duplicate activities at more local scales.

Recommendation 2: The focus of future R&D should aim to address integrated natural resource planning and management issues at the regional scale (ie. whole of catchment, marine bioregion).

8.3 Location of R&D

Resulting from the desktop analysis and perceptions of regional stakeholders, nine terrestrial–marine regional pairings were identified as potential sites for future R&D. These were Broome–Roebuck, Fitzroy–King Sound, North Kimberley, Ord–Bonaparte, Victoria–Bonaparte, Katherine Daly–Bonaparte, Darwin Region, Southern Gulf of Carpentaria, and Western Cape York Peninsula. Five regions were considered to have the highest potential for future R&D. Of these, the analysis indicated that the Ord–Bonaparte region in the Kimberley of WA offers the greatest potential for future R&D aimed at underpinning improved integrated resource planning and management. Other regions, such as the Fitzroy–King Sound, Katherine/Daly–Bonaparte, Western Cape York, Southern Gulf of Carpentaria and Victoria–Bonaparte, also offer significant potential. We argue that the Ord–Bonaparte offers the greatest opportunity for future investment because:

- there is significant stakeholder support for R&D provider involvement in the region, both locally and at State level;
- within northern Australia, the Ord–Bonaparte represents a unique range of ecosystems and land use interactions, and therefore a possible model for evaluating impacts of future similar developments in other regions. This, in conjunction with proposed large scale expansion of irrigation in Ord Stage 2, current commercial fishing effort in the Joseph Bonaparte Gulf, substantial and increasing growth in the tourism sector and rapidly increasing Indigenous control of pastoral and coastal land, make the system highly attractive for R&D investment;
- organisations already appear to be working together for a sustainable regional future. This extends to a far greater level of Indigenous involvement in regional futures being accepted by government that is otherwise unseen in the rest of tropical Australia (with the possible exception of Cape York Peninsula); and
- to date there has been a comparatively small investment of R&D in the Kimberley. With rapidly increasing development pressure in the region, there is a great opportunity to have a substantial positive impact on any future resource use through the application of high quality science.

Recommendation 3: That significant new R&D investment relating to natural resource management in northern Australia be focused on the Kimberley region, with special emphasis on the Ord–Bonaparte area.

8.4 Research & Development Activities

8.4.1 Conceptual Approach to R&D

Integrated approaches to natural resource planning and management must recognise that most decision-making and action occur at regional, catchment and landholder levels. There is often poor interaction between the planning and management activities of different groups with responsibility for resource management in rural regions such as the Kimberley. Most stakeholders have few mechanisms to address issues at the regional or catchment scale (eg. agricultural and pastoral producers, commercial fishermen), while the regional or catchment activities of other groups (eg. State agencies) may not make sense to on-ground land managers. Sustainable natural resource planning and management in the Kimberley will achieve little unless the overall system of planning and management is improved. This means working to develop the planning capacity of all stakeholder groups with natural resource management responsibilities. Regional or catchment management plans have not been developed in the Kimberley. As discussed in Chapter 4, the current limited natural resource planning and management efforts in the region give broad management priorities and actions. However, they do not identify or attempt to establish specific strategies for coordinated planning activities amongst regional or catchment stakeholder groups, nor do they address issues of implementation in detail.

Recommendation 4: A participatory planning systems approach based on sustainability, equity, accountability and integration represents the most appropriate and viable conceptual approach for R&D in the Kimberley region.

8.4.2 Research Proposals

The complexity of recent development trends and possible future developments make it impossible to identify the entire set of opportunities and challenges for natural resource planning and management R&D in the Kimberley. In the Chapter 7, we identified seven major research initiatives for the region and specific projects within each of these initiatives. These research initiatives and projects provide a useful basis for developing R&D proposals. Of these, we consider five to be of high priority, with research proposal number 5 of highest priority. Research proposals 1, 2, 3 and 4 are intended as stand-alone activities, while research proposal 5 represents an integrated package of these 4 proposals.

Recommendation 5: Future R&D relating to natural resource management in the Kimberley should focus on the development and implementation of an integrated package of research as specified in research proposal 5 (Sustainable Development of the Kimberley: Research & Development for integrated planning and management of land water and marine resources in the Ord–Bonaparte region).

8.4.3 Feasibility

The R&D outputs and outcomes likely to emerge from a major investment in the Kimberley will be highly transferable given the lack of, and concomitant demand for, effective models of integrated approaches. Collaboration with government, industry and the community would equip participating R&D providers with a substantial comparative advantage over providers with a narrow sectoral or disciplinary bias. R&D has a fundamental role to play in underpinning current and future natural resource policy, planning and management in the Kimberley due to a serious knowledge gap in both the theory and practice. Effective natural resource planning and management integrates requirements across industry, government and community interests and thus has inherent sectoral and high ‘public good’ components. R&D in this area supports high profile Federal Government policy (eg. aim of COAG water reforms; focus of National Heritage Trust funding), and is of interest to R&D funders (eg. LWRRDC, FRDC, SRDC and MLA). With increasing societal demands for effective natural resource planning and management, growing support for such research is highly likely.

Funding for R&D aimed at improving natural resource planning and management is growing (eg. LWRRDC’s new R&D program on institutional aspects of water resources management) and the area is also of increasing interest to a broad spectrum of potential funding providers. In addition, funding for integrated R&D is likely to continue. Substantial funding reflecting the sectoral and ‘public good’ mix is therefore likely to be achieved. While current funding opportunities are tightly linked to the support of R&D Corporations, we see great potential for securing greater support directly from government and industry. The Central Highlands Consortium in Queensland represents a useful demonstration of the effectiveness of this approach. Unless there are major policy shifts away from supporting R&D for sustainability at both the State and national level, it is highly unlikely that funding for Kimberley region will decline. Given these considerations, the financial feasibility of any potential project is high.

In this study, we have attempted to estimate the likely time and budget requirements for the research proposals specified (Table 34). It is important to note that given the range of activities specified in research proposal 5 (Sustainable Development of the Kimberley: R&D for integrated planning and management of land water and marine resources in the Ord–Bonaparte region), it is highly unlikely that any single organisation or agency would have the capacity to fund the R&D on its own. This is also likely to apply to the other research proposals. Accordingly, we argue that for the R&D specified, a consortium-based approach to funding will be necessary. LWRRDC and FRDC in partnership with CSIRO should take a leadership role in brokering and managing potential consortia. Within the Kimberley, agencies which could contribute to potential R&D funding consortia might include the Kimberley Development Commission, the Kimberley Land Council, the Northern Land Council, the WA Water & Rivers Commission, Agriculture WA, the Ord Irrigation Cooperative, the Shire of Wyndham–East Kimberley, Wesfarmers/Marubeni, WA Pastoralists and Graziers Association, the WA

Department of Resources Development, the WA Ministry for Planning, the WA Department of Environment Protection, the WA Department of Commerce and Trade, the NT Department of Primary Industry and Fisheries, the NT Lands Planning and Environment, the WA Conservation and Land Management, the WA Tourism Commission, Environs Kimberley, CINCRM, the CRC for Sustainable Development of Tropical Savannas, the Australian Institute of Marine Science, Rio Tinto Ltd, ILC, CSR Ltd and CSIRO.

Table 34. Budget and time estimates for recommended research proposals.

Proposal #	Proposed title	Estimated budget (\$'000/yr)	Estimated length (yrs)
RP1	Improving natural resource planning and management capacity in the Kimberley region	735	5
RP2	Improving institutional arrangements for natural resource management and planning in the Kimberley region	360	4
RP3	Impacts of natural resource use on ground and surface waters of the Ord River catchment	1500	4
RP4	Impacts of natural resource use in the Ord River catchment on the marine resource of the Joseph Bonaparte Gulf	1875	4
RP5	Sustainable Development of the Kimberley: R&D for integrated planning and management of land water and marine resources in the Ord–Bonaparte region	3035	5
RPA	Climate variability in the Kimberley region: impacts and options for the Ord–Bonaparte region	1035	4
RPB	Sustainable development of Kimberley tourism: impacts and options for the north and east Kimberley	1060	4

Recommendation 6: LWRRDC and FRDC in partnership with CSIRO seek to facilitate negotiations with stakeholders in the Kimberley region with a view to developing a multi-agency R&D consortium to fund and manage the development and implementation of research proposal 5 in the Ord–Bonaparte bioregion. Seed funding for this activity could be provided by LWRRDC, FRDC, CSIRO and the governments of WA and the NT.

Recommendation 7: If Kimberley stakeholders, R&D providers and R&D funders are unable to negotiate an integrated package of research, LWRRDC and FRDC where appropriate should encourage implementation of component R&D as specified in research proposals 1, 2, 3 and 4.

8.4.4 Risk

There is significant scope to make a substantial R&D contribution in the Kimberley, with clients looking for answers through improved policy, planning and management processes and procedures that can deliver ecological sustainable development. Although the problems that potentially could be addressed are conceptually complex and challenging (eg. cross-disciplinary focus), the chances of success are potentially high. Given the complexity of the R&D, strategic linkages between key social research units are needed to develop synergy with the integrative systems-based role of other R&D providers. Overall there is low technological risk, as the R&D proposed is designed to inform public and industry policy, planning and management rather than being a marketing or commercialisation issue.

In terms of systems synthesis and integration, with the exception of geographic information systems (GIS), the application of decision support tools in resource planning to date has been disappointing (Walker and Johnson, 1996a,b). The best work has had a limited impact as a result of a technology- rather than user-centred approach to design and development. Effective delivery of operationally relevant tools for decision-support in a complex domain, such as natural resource planning and management, requires a range of technical and design requirements to be satisfied. An ongoing and strategic commitment to the development of a resources toolkit for decision-support design, implementation, delivery and evaluation is critical.

Other potential risks to future R&D investment relate to the declining terms of trade of many rural industries in the region and the general decline in the capacity of rural and regional communities to participate in community-based initiatives. This capacity shortfall also currently limits the degree to which Indigenous stakeholders may be able to effectively participate in negotiations over regional resource use. Other potential risks include R&D providers' capacity to maintain a cross-disciplinary R&D capacity in a shrinking resource environment.

8.5 Research Coordination

The following fundamental issues emerged consistently from both the desktop/literature review (Chapters 3–4) and interview process (Chapter 5).

- Both our work and that of previous reviews has highlighted the need for coordinated approaches to undertaking R&D in the tropics, both within and between organisations (see also Chapter 2). Stakeholders saw this issue as being critical to the success of any potential R&D investment in the region.
- As mentioned, stakeholders impressed upon us the significant opportunity that exists to avoid many of the mistakes of the past manifest in southern Australia. However, substantial concern exists over the lack of regional R&D capacity to achieve this.
- The emergence in recent years of significant capacity within Indigenous communities and organisations to both instigate and participate in natural resource planning and management requires a substantial change in approaches to R&D in the tropics. To date, Indigenous issues and peoples have been marginalised in natural resource planning and management R&D and it is clear that this can no longer be the case.

It is apparent that the R&D needs of the Ord–Bonaparte occur at two levels: what might be seen as purely technical (eg. groundwater modelling) and what can be seen as integrative (eg. Ord catchment planning). While the technical work is vital, it should be undertaken in a coordinated way that responds to both individual and regional stakeholder needs. Future R&D needs to have both a rigorous understanding of management needs, and an overall framework for systems synthesis and integration. This will maximise the contribution of R&D to natural resource planning activities in the region.

The R&D options proposed will require the development of research partnerships. These partnerships must necessarily involve government, industry and community stakeholders. We recommend the development of project-specific partnerships that build on existing structures and mechanisms rather than developing new ones (eg. a CRC). Within the Kimberley, stakeholders who could contribute to potential R&D consortia and partnerships could include: the Kimberley Development Commission, the Kimberley Land Council, the Northern Land Council, the Kimberley Aboriginal Pastoralists Association, the WA Water & Rivers Commission, Agriculture WA, the Ord Irrigation Cooperative, the Shire of Wyndham–East Kimberley, Wesfarmers/Marubeni, the WA Pastoralists and Graziers Association, the WA Department of Resources Development, the WA Ministry for Planning, the WA Department of Environment Protection, the WA Department of Commerce and Trade, the NT Department of Primary Industry and Fisheries, NT Lands Planning and Environment, WA Conservation and Land Management, the WA Tourism Commission, Environs Kimberley, CINCRM, the CRC for Sustainable Development of Tropical Savannas, the Australian Institute of Marine Science, consultants (eg. HG Gardiner and Associates), Rio Tinto Ltd, ILC and CSR Ltd. CSIRO Divisions with a capacity to participate include: Marine Research; Tropical Agriculture; Land and Water; Maths and Information Sciences; Wildlife and Ecology; Building, Construction and Engineering; Plant Industry; Atmospheric Research; Energy Technology; Minerals; and Entomology.

We do not propose any new structures for research coordination in the Kimberley, rather we recommend that new R&D build on and enhance existing mechanisms and processes. We also argue that any major new R&D investment in the Kimberley region will require a significant enhancement of resident R&D in Kununurra. While skills and expertise can be drawn from Darwin, Perth, Brisbane, Townsville and Canberra, improved resident R&D capacity will be essential for the successful conduct of any integrated R&D in the region. This view was strongly supported by stakeholder feedback to earlier drafts of this report.

Recommendation 8: We recommend the development of project specific partnerships that build on existing structures and mechanisms rather than developing new ones.

Recommendation 9: Successful implementation of any integrated R&D effort in the Ord–Bonaparte will require the development of an enhanced resident R&D capacity in Kununurra. While expertise can be obtained from other centres on a fly-in, fly-out basis, it is fundamental that a critical mass of R&D personnel be physically located in the region for the life of the project.

8.6 Other Issues

This study has identified a range of issues to which R&D can contribute in furthering integrated natural resource planning and management. However, there were issues that were clearly beyond the scope of potential R&D interventions. These principally related to stakeholder capacity and institutional issues. Although not the focus of this study, it is important to briefly discuss them in relation to a material presented in previous sections.

8.6.1 Capacity Building

As previously stated, capacity building is anything that enables communities, organisations and individuals to effectively participate in and achieve desired outcomes from resource management and planning processes. R&D does have a role in capacity building through the development of resource management tools and methods, the collection and collation of data, and in improving the general understanding of resource management issues and approaches by stakeholders. For example, capacity building could include the building of skills in a particular resource management process (eg. aquaculture) or developing a common community planning language.

Lack of human and financial resources, not surprisingly, emerged as the core constraint to improving the effectiveness of a range of natural resource planning and management activities in the region. In particular, lack of human resources, whether because of the remote nature of the north or the lack of financial resources was critical. Lack of a scientific ‘critical mass’ in the region was also a problem, both in absolute terms, as well as the degree to which present numbers limit the recruitment of additional scientists into the region. A third issue relates to the inability of government agencies to recruit experienced staff to the region and to retain skilled staff in the long term.

This study has also identified three additional areas within the domain of stakeholder capacity building that will be critical prerequisites to sustainable natural resource planning and management in the Kimberley region. These are:

- **Resourcing for equitable participation** – clearly, one way to ensure adequate and equitable participation within stakeholder groups is to ensure that resources existing within and provided to such groups are equitably distributed.
- **Community-based education, leadership training and personal development** – Stakeholder groups can enhance the participation of their constituents by facilitating broad education about environmental and land management issues in their areas of concern. Equally, providing leadership training and personal development opportunities may build additional capacity within the group. These activities improve the ability of interest groups to plan and to be involved in negotiations over resource management. The Kowanyama Aboriginal Land and Natural Resource Management Office in Western Cape York Peninsula, for example, is a significant stakeholder in ICM in the Mitchell River watershed. It has a detailed community-education strategy, including the development of an accredited natural resources management curriculum in the school and community education programs about burning and coastal care (KALNRMO, 1994).
- **Community-based monitoring and evaluation** – One practical way to improve the effectiveness of participation of stakeholder group constituents is to directly involve as many people as is possible in the data collection and monitoring needed to inform the group’s involvement in negotiation. This not only assists the strength of the plan making process in an educational sense, but also continues to develop group ownership and commitment to the negotiation process. Alexandra *et al.* (1996) have published a directory of community-based groups involved in environmental monitoring across Australia. They consider that the direct involvement of constituents in environmental monitoring leads participants to develop a stronger sense of responsibility for managing resources. In the Kimberley region, such programs are under discussion between AgWA’s Kimberley Beef Team and the Kimberley Aboriginal Pastoralists Association (G. Brennan, AgWA, pers. comm.). Interest groups can also strive to involve their constituents as much as

possible in monitoring and evaluating the plans they use as the basis for their involvement in resource management negotiations. Apart from involving people in the collection of physical data, as discussed above, considerable effort should be put into monitoring how people feel their interests are being met by both the stakeholder group's planning and the overall negotiation process. ATSI (1994) outlines a number of techniques that can be used to achieve this.

8.6.2 Institutional Reform

Although R&D may underpin or influence debate on institutional reform, political considerations will largely dominate the process. Several reports have been completed or prepared in the last five years that have recommended legislative and structural reform in natural resource planning and management (eg. *inter alia* ASTEC, 1993; RAC, 1993; IC, 1997; MacLeod *et al.*, 1997). In general, their recommendations have been clearly supported by the responses from stakeholders we received (Chapter 5). Further, there has been some institutional change in response to:

- calls for a regional approach to natural resource planning;
- recognition of the need to accommodate multiple resource values;
- an increasingly diverse and demanding domain of stakeholders;
- High Court decisions in Mabo No. 2 and Wik;
- uncertainty surrounding the sustainability of current land use; and
- changing understanding of the scales for management and the role of government.

Notwithstanding these, the most common issue raised during the course of this study was the need for increased or improved coordination and consistency between the roles and responsibilities of government agencies, functions, and the legislation they administer. This included the need to develop appropriate regional planning mechanisms and frameworks. This is not to suggest that agencies are entirely uncoordinated in their responses, or that no communication occurs between them. Rather, stakeholders clearly perceive that this does not occur in a strategic way, and in a way accessible to people outside government. This issue is not unique to the study area, and possibly as much through limited capacity for reform as through lack of political will, rarely sees implementation through the political process. The provision of potential models for reform, premised on effective institutional understanding and analysis, is however, an R&D issue (eg. Dale and Bellamy, 1998).

Beyond this, the most significant institutional reform for tropical Australia is the incorporation of legislative and judicial recognition of Aboriginal land rights into moves toward regional strategic land use and development planning (Holmes, 1994). The change in land ownership and rights over the last 20 years (particularly through the *Aboriginal Land Rights (Northern Territory) Act 1976* and subsequently through Mabo No 2, Wik and the *Native Title Act 1993*) toward increased Aboriginal ownership, is probably the most significant change. Again, although frequently cited both within and outside Indigenous organisations as a core issue in integrated resource management, effective integration of Indigenous rights and issues through these mechanisms, even on Indigenous controlled land, remains elusive. Examples of institutional change often cited, such as joint management of protected areas, are still predominantly non-Indigenous management mechanisms and decision fora, and frequently fail to reflect Indigenous land use aspirations.

8.7 Conclusion

This chapter has clearly outlined a potential path for future R&D in tropical Australia and identified the Kimberley region as having the greatest potential for R&D to improve the planning and management of natural resource use. We hope that results presented in this study will catalyse more detailed discussion between R&D providers and stakeholders in the Kimberley. Although this final chapter has focused on potential R&D investments in the Kimberley, significant opportunity exists for R&D in other parts of the northern Australia, particularly western Cape York and the southern Gulf of Carpentaria. Indeed, it is hoped that this report may stimulate further discussions with stakeholders in those regions. It is clear that R&D to enhance planning and management of natural resources in tropical Australia strongly serves the national interest. Given the current ecological, social and environmental challenges facing this extensive zone of Australia, future R&D should build on the diversity of information summarised in this scoping study and comprehensively address the key issues and priorities identified here.

Bibliography

- AC [Aquaculture Committee] 1997. *National Strategy on Aquaculture in Australia: Implementation Review*. Fisheries and Aquaculture Branch, Department of Primary Industries and Energy, Canberra.
- Alexander, E.R. 1986. *Approaches to Planning: introducing current planning theories, concepts, and issues*. Gordon and Breach, New York .
- Alexandra, J., Haffenden, S., and White, T. 1996. *Listening to the Land: a directory of community environmental monitoring groups in Australia*. Australian Print Group, Maryborough.
- ALGA [Australian Local Government Association]. 1992. *Towards integrated local area planning*. Second. Union Offset Co Pty Ltd, Canberra.
- Altman, J., Ginn A., and Smith D.E. 1993. *Existing and Potential Mechanisms for Indigenous Involvement in Coastal Zone Management: a consultancy report to the Coastal Zone Inquiry*. Resource Assessment Commission, Canberra.
- Altman, J.C., Bek H.J., and Roach, L.M. 1995. *Native Title and Indigenous Australian Utilisation of Wildlife: policy perspectives*. Centre for Aboriginal Economic Policy Research, ANU, Canberra.
- ANAO [Australian National Audit Office]. 1997. *Commonwealth Natural Resource Management and Environment Programs: Australia's land, water and vegetation resources*. Auditor General, Canberra.
- ANZECC [Australian and New Zealand Environment and Conservation Council] and ARMCANZ [Agriculture and Resource Management Council of Australia and New Zealand]. 1996. *Draft National Strategy for Rangeland Management*. Department of Environment Sport and Territories, Canberra.
- Aquaculture Committee. 1997. *National Strategy on Aquaculture in Australia: Implementation Review*. Department of Primary Industries and Energy, Fisheries and Aquaculture Branch, Canberra.
- ARMCANZ and ANZECC. 1997. *The National Weeds Strategy: a strategic approach to weed problems of national significance*. Commonwealth of Australia, Canberra.
- Arthington, A.H., Marshall, J.C., Rayment, G.E., Hunter, H.M., and Bunn, S.E. 1997. Potential impact of sugarcane production on riparian and freshwater environments., in Keating, B. A. and Wilson, J. R. (eds) *Intensive Sugarcane Production: meeting the challenges beyond 2000*. CAB International, Wallingford, U.K.
- ASTEC [Australian Science and Technology Council]. 1993. *Research and Technology in Tropical Australia and Their Application to the Development of the Region: final report*. Australian Science and Technology Council, Canberra.
- ATSIC [Aboriginal and Torres Strait Islander Commission] 1994. *Community-based Planning: Principles and Practices*. ATSIC, Canberra.
- ATSIC [Aboriginal and Torres Strait Islander Commission] and ONT [Office of National Tourism]. 1997. *National Aboriginal and Torres Strait Islander Tourism Strategy*. ATSIC, Canberra.
- Barson, M., Wood, B., and Howe, D. 1997. *Priorities for Land Resource Assessment in Australia: Northern Territory soil and land resource assessment needs*. Draft report prepared for National Landcare Program Project 935715, Value and Priorities for Land Resource Assessment for National Purposes.
- Beare, S., Gooday, J., Doyle, S., and Ockerby, J. 1995. Agriculture in the rangelands. A study of economic viability. *Australian Commodities* 2 (4): 498–510.
- Bellamy, J.A. and Johns, A.K.L. 1997. ICM and sustainable agriculture: moving from rhetoric to practice. *Proceedings, 2nd National Conference on Integrated Catchment Management*, 29 September–1 October 1997. River Basin Society, Inc., Mt Waverley, Victoria.
- Bellamy, J.A. and Johnson, A.K.L. 1998. Integrated resource management: moving from rhetoric to practice in Australian agriculture. *Environmental Management* (in press).
- Bellamy, J. A., McDonald, G. T., Syme, G. J., and Butterworth, J. E. 1998. Evaluating integrated resource management. *Society and Natural Resources* 12 (in press).
- Beumer, J., Carseldine, L. and Zeller, B. 1997. *Declared Fish Habitat Areas in Queensland*. Fisheries Group, Department of Primary Industries, Brisbane.
- Billyard, R. and Pyne, R. 1996. Marine conservation and marine protected areas in the Northern Territory. In: Zann LP (compiler). *The State of the Marine Environment Report for Australia. Technical Summary*. Great Barrier Marine Park Authority, Townsville, Australia. pp. 493–498.

-
- Bird, J. 1996. The coastal zone: an introduction. In: Zann LP (compiler). *The State of the Marine Environment Report for Australia. Technical Summary*. Great Barrier Marine Park Authority, Townsville, Australia. pp. 1–8.
- Black, A. W. 1995. Policy instruments designed to foster sustainable agriculture. *Rural Sociology and Development* 6: 123–147.
- Bleakley, C., Ivanovici, A. and Ottesen, P. 1996. An assessment of marine protected areas in Australia. In: Zann LP (compiler). *The State of the Marine Environment Report for Australia. Technical Summary*. Great Barrier Marine Park Authority, Townsville, Australia. pp. 403–410 .
- Bokhari, S. M. H. 1977. Institutional arrangements for planning and management of water resources in Pakistan: a case study. *Natural Resources Forum* 1: 131–143 .
- Boehmer-Christiansen, S. 1994. Politics and environmental management. *Journal of Environmental Planning and Management* 37(1): 69–85.
- Born, S. M. and Rumery, C. 1989. Institutional aspects of lake management. *Environmental Management* 13 (1): 1–13 .
- BRS [Bureau of Resource Sciences] 1995. *Australia's Identified Mineral Resources 1994*. BRS, Canberra.
- CALM [Conservation and Land Management]. 1994. *A Representative Marine Reserve System for Western Australia: Report of the Marine Parks and Reserves Selection Working Group*. Department of Conservation and Land Management, Perth.
- Cappo, M., Alongi, D.M., Williams, M., and Duke, N. 1998. *A Review and Synthesis of Australian Fisheries Habitat Research*. Australian Institute of Marine Science, Townsville .
- Carr, A. 1993. *Catchment Co-management: The case of the Mitchell River Watershed Management Working Group*. Centre for Resource and Environmental Studies, ANU, Canberra .
- Chase A. 1990. Anthropology and Impact Assessment: development pressures and indigenous interests in Australia. *Environmental Impact Assessment Review* 10 (1–2): 11–23 .
- Chudleigh, P.D., Bramwell, T.M., and McLeod, R. 1997. *R&D Priorities for Environmental and Resource Management in the Australian Sugar Industry*. Land and Water Resources Research and Development Corporation, Occasional Paper 06/97, Canberra .
- CINCRM [Centre for Indigenous Natural and Cultural Resource Management]. date accessed 15/9/1998. *homepage* [Web Page]. Available at: www.ntu.edu.au/cincrm/
- Clements, R.J. 1996. Summaritive address: perceptions, issues, trends and roles. In: Ash, A.J., ed. *The Future of Tropical Savannas: an Australian Perspective*. CSIRO, Australia.
- COAG [Council of Australian Governments]. 1992a. *Intergovernmental Agreement on the Environment*. Australian Government Publishing Service, Canberra .
- COAG [Council of Australian Governments]. 1992b. *National Strategy for Ecologically Sustainable Development*. Australian Government Publishing Service, Canberra Commonwealth of Australia. 1992. *National Strategy for Ecologically Sustainable Development*. Australian Government Publishing Service, Canberra.
- Commonwealth of Australia 1998. *Australia's Ocean Policy*. Environment Australia, Canberra, Australia. ISBN 0 642 54580 4. 48 pp .
- Connell, J. and Howitt, R. 1991. Mining, dispossession and development, in Connell, J. and Howitt, R. (eds) *Mining and Indigenous Peoples in Australasia*. Sydney University Press, NSW.
- Coombs, H.C. 1980. Impact of uranium mining on the social environment of the Aborigines in the Alligator River region, in Harris, S. *Social and Environmental Choice*. Centre for Resource and Environmental Studies, Canberra .
- Cordell, J. 1992. *Managing Sea Country: Tenure and Sustainability of Aboriginal and Torres Strait Islander Marine Resources*. Fisheries Working Group.
- Cordell, J. 1995. *Indigenous Management of Land and Sea Project*. Report for CYPLUS Land Use Program, Queensland .
- Cortner, H. J. and Moote, M. A. 1994. Trends and issues in land and water resources management: setting the agenda for change. *Environmental Management* 16(1): 167–173 .
- Costanza, R., Funtowicz, S. O., and Ravetz, J. R. 1992. Assessing and communicating data quality in policy-relevant research. *Environmental Management* 16(1): 121–131.

-
- Cowell, S.G. 1996. *Aboriginal interests and the Century Zinc proposal: resource planning, development and impact assessment in the Gulf of Carpentaria*. Unpublished Honours dissertation. Griffith University, Brisbane.
- Craig, D. 1991. Aboriginal interests and perspectives. In: Handmeyer, J.W., Dorcey, A. and Smith, D.I. (eds), *Negotiating Water: Negotiating Conflict Resolution in Australian Water Management*. Centre for Resource and Environmental Studies, Canberra.
- Crossland, C.J., Done, T.J., and Brunskill, G.J. 1997. Potential impacts of sugarcane production on riparian and freshwater environments, in Keating, B. A. and Wilson, J. R. (eds) *Intensive Sugarcane Production, Meeting the Challenges Beyond 2000*. CAB International, Wallingford U.K.
- CYRAG [Cape York Regional Advisory Group]. 1997. *Cape York Peninsula Land Use Strategy—Our Land Our Future: Stage 2 Report a Strategy for Sustainable Land Use and Economic and Social Development*. Qld Dept of Local Government, Commonwealth Department of Environment Sport and Territories, Canberra.
- Dale, A. 1992. Planning for rural development in Aboriginal communities: a community based planning approach, in Moffatt, I. and Webb, A. (eds) *Conservation and Development Issues in Northern Australia*. North Australia Research Unit, ANU, Darwin.
- Dale, A. and Bellamy, J. 1998. *Regional Resource Use Planning in Rangelands: An Australian Review*. Land and Water Resources Research and Development Corporation Occasional Paper 06/98, LWRRDC Canberra.
- DARTI [Department of Asian Relations, Trade and Industry] 1997. *Strategic Directions 1997–1999*. DARTI, Darwin.
- DARTI [Department of Asian Relations, Trade and Industry] 1998. *Northern Territory Major Projects*. DARTI, Darwin.
- Davis, G. and Weller, P. 1993. *Strategic Management in the Public Sector: managing the coastal zone, a report prepared for the Resources Assessment Commission*. Centre for Australian Public Sector Management, Griffith University, Brisbane.
- DCT [Department of Commerce and Trade] 1998. *Western Australian Regional Development Policy Draft Scoping Paper 2: an overview of regional development in State Government agencies*. Department of Commerce and Trade, Perth.
- DEH [Department of Environment and Heritage] 1998. *Descriptions of endangered marine wildlife*. <http://www.env.qld.au>
- DEP [Department of Environmental Protection]. 1998. *North West Shelf Marine Environmental Management Study Draft Scoping Paper*. DEP, Perth.
- Department of Primary Industry and Fisheries 1997. *Technical Annual Report 1996/97*. Darwin, Australia. ISSN 0158-2763. 219 pp.
- Department of Primary Industry and Fisheries 1998. *Annual Report 1997/98*. Darwin, Australia. ISSN 1034-7356. 142 pp.
- DEST [Department of Environment, Sport and Territories] 1996. *National Strategy for the Conservation of Biological Diversity*. DEST, Canberra.
- Dews, G.J. 1997. *ICC Feasibility Study on Indigenous Protected Areas in Torres Strait*. Island Coordinating Council, Thursday Island.
- DLGP (Department of Local Government and Housing, Queensland) 1997. *Draft Gulf Regional Development Program*. DGLP, Brisbane.
- DMR [Department of Main Roads]. 1997. *Roads Implementation Program 1997–98 to 2001–02*. DMR, Brisbane.
- DNR [Department of Natural Resources]. 1997. *Water Infrastructure Planning and Development: 1997–98 to 2001–02 Implementation Plan*. DNR, Brisbane.
- Dorcey, A. 1986. *Bargaining in the Governance of Pacific Coastal Resources: Research and Reform*. Westwater Research Centre, University of British Columbia, Vancouver.
- Dorcey, A. 1991. Conflict resolution in natural resources management: sustainable development and negotiation, in Handmer, J. W., Dorcey, A. H. J., and Smith, D. I. (eds) *Negotiating Water: Conflict resolution in Australian Water Management*. Centre for Resource and Environmental Studies, Australian National University, Canberra.
- Dovers, S. 1995. Risk, uncertainty and ignorance: policy processes and institutional issues. In: Norton, T. W., Beer, T., and Dovers, S. R. (eds) *Risk and Uncertainty in Environmental Management: proceedings of the*
-

-
- 1995 Australian Academy of Science Fenner Conference on the Environment, 13–16 November 1995. Centre for Resource and Environmental Studies, ANU, Canberra.
- Dovers, S.R. and Mobbs, C.D. 1997. An alluring prospect? ecology and the requirements of adaptive management, Klomp, N. and Lunt, I. (eds) *Frontiers in Ecology: building the Links*. Elsevier Science, New York.
- DPIE [Department of Primary Industries and Energy] 1997. *Petroleum and Fisheries Division – Business Plan*. DPIE, Canberra.
- DRD. date accessed 22/7/1998. *homepage* [Web Page]. Available at: <http://www.drd.wa.gov.au/index.htm>
- DSD [Department of State Development]. 1998. *Projects Queensland*. DSD, Brisbane.
- DTSBI [Department of Tourism, Small Business and Industry] 1996. *Projects Queensland: major development projects and proposals in Queensland, Australia*. Number 16. DTSBI, Brisbane.
- DTW [Department of Transport and Works]. 1996. *Road Network Strategy*. DTW, Darwin.
- Dutton, I. and Luckie, K. 1996. Impacts of tourism on marine and coastal systems. In: Zann, L.P. (compiler). *The State of the Marine Environment Report for Australia. Technical Summary*. Great Barrier Marine Park Authority, Townsville, Australia. pp. 166–171.
- EA [Environment Australia] 1995. *Commonwealth Coastal Policy*. Environment Australia, Canberra.
- Eager, E. and Campbell, J. 1996. Marine conservation and marine protected areas in Queensland. In: Zann L.P. (compiler). *The State of the Marine Environment Report for Australia. Technical Summary*. Great Barrier Marine Park Authority, Townsville, Australia. pp. 458–465.
- EA [Environment Australia] 1998. *Australia's Ocean's Policy An Issues Paper: Caring–Using–Understanding*. Environment Australia Portfolio Marine Group, Canberra.
- Finlayson, C.M., Hall, R., and Bayliss, B. 1997. *National Wetlands R&D Program Regional Review of Wetlands Management Issues: wet dry tropics of northern Australia*. Land and Water Resources Research and Development Corporation, Canberra.
- Fisheries Department of Western Australia and KDC 1996. *Kimberley Aquaculture Development Plan*. Fisheries Department of Western Australia and KDC, Perth.
- Fisheries Western Australia 1997. *Fisheries Department of Western Australia Annual Report 1996–1997*. Government of Western Australia, Perth.
- Fisheries WA 1997. *Strategic Plan 1997–2002*. Fisheries WA, Perth.
- Fisheries WA 1998. DRAFT Position paper: Management of indigenous fishing activities within Western Australia. Fisheries WA, Perth Australia.
- FRDC [Fisheries Research and Development Corporation] 1999. FRDC Board sees the aqua potential of the far north; Lake Argyle barra worth \$50m. *R&D News* 7(1): 8–9.
- Fredericksen, H.D. and Berkoff, J.B.W. 1994. *Principles and Practices for Dealing with Water Resource Issues*. World Bank, Washington D.C.
- Funtowicz, S.O. and Ravetz, J.R. 1990. *Uncertainty and Quality in Science for Policy*. Kluwer Academic Publishers, Netherlands.
- FWA [Fisheries Western Australia] and KDC [Kimberley Development Commission] 1996. *Kimberley Aquaculture Development Plan*. FWA/KDC, Perth, WA.
- Garside, A.L., Smith, M.A., Chapman, L.S., Hurney, A.P., and Magarey, R.C. 1997. The yield plateau in the Australian sugar industry: 1970–1990. In: Keating, B. A. and Wilson, J. R. (eds) *Intensive Sugarcane Production, Meeting the Challenges Beyond 2000*. CAB International, Wallingford, U.K.
- Gill, R. 1996. *R&D Priorities for Ecological Economics*. Land and Water Resources Research and Development Corporation Occasional Paper 09/96, Canberra.
- GLADA [Gulf Local Authorities Development Association]. date accessed 7/1997. *homepage* [Web Page]. Available at: <http://internetnorth.com.au/finqredo1/glada.html>
- Graham, R. J. 1993. The role of local government in environmental management. *Environment South Australia* 2 (3): 12–13.
- Griffin, R.K. 1995. Recreation fishing surveys in the Northern Territory—1978 to 1993. In: Hancock DA (ed.). *Recreational fishing: what's the catch*. Australian Society for Fish Biology Workshop Proceedings, Canberra 30–31 August 1994. Australian Society for Fish Biology, Canberra. ISBN 0 644 35992 7. 220–224.
- Gunderson, L.H., Holling, C.S., and Light, S.S. 1995. *Barriers and Bridges to the Renewal of Ecosystems and Institutions*. Columbia University Press, New York.
-

-
- Hancock, D.A. (ed.) 1995. *Recreational fishing: what's the catch*. Australian Society for Fish Biology Workshop Proceedings, Canberra 30–31 August 1994. Australian Society for Fish Biology, Canberra. ISBN 0 644 35992 7. 274 pp.
- Hoey, W. 1996. *The National Rangelands Management Strategy –striking a balance: paper presented at ABARE Outlook 96 Conference*. Australian Bureau of Agricultural and Resource Economics, Canberra.
- Holmes, J. 1992. *Strategic Regional Planning on the Northern Frontiers*. NARU Discussion Paper 4, Darwin.
- Holmes, J.H. 1994. *The Future of Tropical Savannas: managing resources and resolving conflicts*. Australian Bureau of Agricultural and Resource Economics, Townsville.
- Holmes, J.H. 1996a. Changing Resource Values in Australia's Tropical Savannas: priorities in institutional reform, in Ash, A. (ed) *The Future of Tropical Savannas: an Australian perspective*. CSIRO, Australia.
- Holmes, J.H. 1996b. Regional restructuring of the tropical savannas: impacts on lands, people and human settlements, Ash, A. (ed) *The Future of Tropical Savannas: an Australian perspective*. CSIRO, Australia.
- Hook, R. 1997. *Catchment Management, water quality and nutrient flows as they relate to the northern beef industry: an overview of literature and current research*. Report for MRC/NAP3, Sydney/Canberra.
- Hook, R. 1998. *The North Australia Program: catchment management, water quality and nutrient flows & the northern Australian beef industry*. Meat and Livestock Australia, North Sydney.
- HORSCERA [House of Representatives Standing Committee on Environment, Recreation and the Arts]. 1991. *The Injured Coastline: protection of the coastal environment*. Australian Government Publishing Service, Canberra.
- Howitt, R. 1993. Social impact assessment as 'applied peoples' geography'. *Australian Geographical Studies* 31(2): 127–140.
- Hundloe, T. 1985. *Fisheries of the Great Barrier Reef*. Special publication series. Great Barrier Reef Marine Park Authority, Townsville.
- Hyman, E.L. and Stiftel, B. 1988. *Combining Facts and Values in Environmental Impact Assessment*. Westview Press, Boulder.
- IC [Industry Commission]. 1997. *A Full Repairing Lease: inquiry into ecologically sustainable land management draft report*. Industry Commission, Canberra.
- ILC [Indigenous Land Corporation]. 1996a. *Regional Indigenous Land Strategy 1996–2001: Western Australia Regional Area*. ILC, Adelaide.
- ILC [Indigenous Land Corporation]. 1996b. *Regional Indigenous Land Strategy 1996–2001 Northern Territory Regional Area*. ILC, Adelaide.
- ILC [Indigenous Land Corporation]. 1996c. *Regional Indigenous Land Strategy 1996–2001 Queensland Regional Area*. ILC, Adelaide.
- IMCRA Technical Group [Interim marine and Coastal Regionalisation for Australia]. Date accessed 20/8/1998. *Interim marine and Coastal Regionalisation for Australia: An Ecosystem-Based Classification for Marine and Coastal Environments Version 3.2* [Web Page]. Available at: http://www.environment.gov.au/marine/natmis/aust_programs/imcra/IMCRA.html#theorie
- IRDB [Integrated Regional Database] 1998. ABS Catalogue Number 1353.0. Australian Bureau of Statistics, Canberra.
- Israel, A. 1987. *Institutional Development*. Johns Hopkins University Press, Baltimore.
- Johnson, A.K.L. and Bellamy, J.A. 1998. *Managing for Ecological Sustainability: moving from rhetoric to practice in the Australian sugar industry*. Conference Proceedings, Managing for Ecological Sustainability, Centre for Conservation Biology, University of Queensland, Brisbane, in press.
- Johnson, A.K.L., Cowell, S.G., Walker, D.H., and Dale, A.P. 1998. *Southern Gulf of Carpentaria & North West Queensland: An Assessment of Natural Resource Policy, Planning and Management Processes*. CSIRO Tropical Agriculture, St Lucia, Qld .
- Johnson, A.K.L., McDonald, G.T., Shrubsole, D.A., and Walker, D.H. 1998. Natural Resource Use and Management in the Australian Sugar Industry: current practice and opportunities for improved policy, planning and management. *Australian Journal of Environmental Management* 5 (2): 97–108 .
- Johnston, R. 1996. *Still Our Country: Aboriginal perspectives on rangelands management. Submission to the National Rangeland Management Working Group for the National Strategy for Rangeland Management and Action Plan*. Central Land Council, Alice Springs.
- Jones, A. and Thronthwaite, T. 1994. *Regional Social Infrastructure Planning: from Experiments to Policies*. Queensland Council of Social Services, Brisbane.

-
- Kailola, P.J. Williams, M.J., Stewart, P.C., Reichelt, R.E., McNee, A. and Grieve, C. 1993. *Australian Fisheries Resources*. Commonwealth of Australia, Canberra.
- KALNRMO [Kowanyama Aboriginal Land and Natural Resource Management Office]. 1994. *Strategic Directions: 1994*. KALNRMO, Kowanyama.
- KDC 1997. *Kimberley Region Western Australia: Economic Development Strategy 1997–2010*. KDC, Kununurra.
- Keating, B.A., Bauld, J., Hillier, J., Ellis, R., Weier, K.L. Sunners, F. and Connell, D. 1995. Leaching of nutrients and pesticides to Queensland groundwaters. *Proceedings, National Conference on Downstream Effects of Land Use*. 26–28 April 1995, University of Central Queensland, Rockhampton.
- Kelty, B. 1993. *Developing Australia: a regional perspective. A report to the Federal Government by the Taskforce on Regional Development*. (3 volumes) National Capital Printing, Canberra.
- Kirby, G., Crough, G., Murit, S., Koldowski, J. and Vemuri, R. 1995. The tropical savanna economy of northern Australia. Paper presented at the Northern Australian Regional Outlook Conference, Darwin, NT, 12 October 1995. Office of Northern Development, Darwin [unpublished].
- KRPG [Kimberley Regional Partnership Group] 1997. *Sustainable Rural Development Program: Strategic Plan 1997–2002*. AGWA, Perth.
- KWADSSC [Kununurra–Wyndham Area Development Strategy Steering Committee]. 1998. *Kununurra–Wyndham Area Development Strategy Discussion Paper*. Ministry for Planning, Kununurra.
- Lane, M.B. and Dale, A.P. 1995. Project assessment in Australian indigenous domains: the case for reform. *Australian Journal of Environmental Management* 2(1): 30–39.
- Lang, R. 1990. *Integrated Approaches to Resource Planning and Management*. Banff Centre School of Management, University of Calgary, Canada.
- Langton, M. 1998. *Burning Questions; Emerging environmental issues for indigenous peoples in north Australia*. Centre for Indigenous Natural and Cultural Resource Management.
- Lockie, S. and Vanclay, F., eds. 1997. *Critical Landcare*. Centre for Rural Social Research, Charles Sturt University, Wagga Wagga.
- Loneragan, N.R. and Bunn, S.E. 1999. River flow and estuarine food-webs: implications for the production of coastal fisheries with an example from the Logan River, southeast Queensland. *Australian Journal of Ecology* (in press).
- Loneragan, N.R., Kenyon, R.A., Staples, D.J., Poiner, I.R. and Conacher, C.A. 1998. The influence of seagrass type on the distribution and abundance of postlarval and juvenile tiger prawns in the western Gulf of Carpentaria, Australia. *Journal of Experimental Marine Biology and Ecology* 228: 175–196.
- Lovei, M. and Weiss, C.Jr. 1998. *Environmental Management and Institutions in OECD Countries: lessons from experience*. Pollution Management series: World Bank Technical Paper No. 391, World Bank, Washington D.C.
- McIntyre, S. and McIvor, J. 1998. *Diversity and Sustainability in Grassy Eucalypt Ecosystems*. Land and Water Resources Research and Development Corporation Occasional Paper 04/98, LWRRDC, Canberra.
- Ludwig, J., Tongway, D., Freudenberg, D., Noble, J. and Hodgkinson, K., eds 1997. *Landscape Ecology, Function and Management: Principles from Australia's Rangelands*. CSIRO Australia, Melbourne, 158 pp.
- McLennan, W. 1996. *Australians and the Environment*. Catalogue No. 4601.0, Australian Bureau of Statistics, Canberra.
- McLeod, P., Agnew, M., Flugge, N., Gardiner, G., and Matiske, L. 1997. *Draft Report of the Task Force for the Review of Natural Resource Management and Viability of Agriculture in Western Australia*. Perth.
- MAGOP [Ministerial Advisory Group on Oceans Policy]. 1998. *Australia's Oceans Policy: Report of the Ministerial Advisory Group on Oceans Policy*. Environment Australia, Canberra.
- Martin D.F. and Taylor, J. 1995. *Enumerating the Aboriginal Population in Remote Australia: methodological and conceptual issues*. Discussion Paper No. 91. Centre for Aboriginal Economic Policy Research, ANU, Canberra.
- Mason, R.O. and Mitroff, I.I. 1981. *Challenging Strategic Planning Assumptions: theory, cases and techniques*. John Wiley and Sons, New York.
- Massam, B.H. 1988. Multi-Criteria Decision Making (MCDM) techniques in planning, Diamond, D. and McLoughlin, J. B. *Progress in Planning*. Pergamon Press, Oxford.
- Mercer, D. 1991. *A Question of Balance: natural resources conflict in Australia*. Federation Press, Annandale, NSW.

-
- Mitchell, B. 1997. *Resource and Environmental Management*. Longman, Essex, U.K.
- Mitchell, B. and Hollick, M. 1993. Integrated catchment management in Western Australia: transition from concept to implementation. *Environmental Management* 17 (6): 735–743.
- Moffatt, I. 1990. The potentialities and problems associated with applying information technology to environmental management. *Journal of Environmental Management* 30: 209.
- Moon, B. 1998. Reforming the Queensland land-use planning legislation: an agenda driven by myth and rhetoric. *Australian Planner* 35 (1): 24–31.
- Morton, S.R. and Price, P. 1994. *R&D for Sustainable Use and Management of Australia's Rangelands*. Occasional Paper No. 06/93, LWRRDC, Canberra.
- Morton, S.R., Stafford Smith, D.M., Friedel, M.H., Griffin, G.F., and Pickup, G. 1995. The stewardship of arid Australia: ecology and landscape management. *Journal of Environmental Management* 43: 195–217.
- MSTPWG [Marine Science and Technology Plan Working Group]. 1998. *Marine Science and Technology Plan: draft for consultation*. Commonwealth Department of Industry, Science and Tourism, Canberra.
- National Farmers Federation. 1997. *Annual Report 1997*. National Farmers' Federation, Canberra.
- Nel, S. 1997. *Kimberley Aquaculture Development Plan*. Kimberley Development Commission & Fisheries Department of Western Australia, WA.
- Niblett, M. 1993. *Borrooloola Community Development Planning Study Interim Report and Recommendations — The MIM–McArthur River Mine Development: Assessment of Impact on the Aboriginal Population of Borrooloola Township and Region*. NLC for Mabunji Aboriginal Resource Association.
- Nicholson, A. and Cane, S. 1996. Pre-European use of the sea by Aboriginal people: an archaeological perspective. In: Zann LP (compiler). *The State of the Marine Environment Report for Australia. Technical Summary*. Great Barrier Marine Park Authority, Townsville, Australia. pp. 99–103.
- Northern Territory Government. 1996. *Darwin 2010: the multi-modal transport and logistics hub*. Northern Territory Government, Darwin.
- Norton, T., Nix, H., and Williams, J. 1996. Risk, uncertainty and cumulative environmental change, in Norton, T. W., Beer, T., and Dovers, S. R. *Risk and Uncertainty in Environmental Management, Proceedings of the 1995 Australian Academy of Science Fenner Conference on the Environment, 13–16 November 1995*. Centre for Resource and Environmental Studies, Canberra.
- Novelly, P. 1994. *Ord River Catchment: situation statement*. Unpublished Report, Department of Agriculture, W.A.
- NRMWG [National Rangelands Management Working Group]. 1994. *Rangelands Issues Paper, February 1994*. Australian Government Publishing Service, Canberra.
- NRMWG [National Rangelands Management Working Group]. 1996. *Draft National Strategy for Rangeland Management*. Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). Department of Environment, Sports and Territories, Canberra.
- NRTEE [National Round Table on the Environment and the Economy]. 1998. *Sustainable Strategies for Oceans: a co-management guide*. National Round Table on the Environment and the Economy, Ottawa.
- Oakley, P. 1991. The concept of participation in development. *Landscape and Urban Planning* 20: 115–122.
- O'Faircheallaigh, C. 1991. Mining and economic development in the Northern Territory: what we know, what we need to know. In: Moffat, I. and Webb, A. (eds), *North Australian Research: some past themes and new directions*. North Australian Research Unit, ANU, Canberra.
- OND [Office of Northern Development] 1994. *Towards the Development of a North Australia Social Justice Strategy: final report*. Commonwealth Department of Housing and Regional Development, Darwin.
- Oreskes, N., Shrader-Frechette, K., and Belitz, K. 1994. Verification, validation, and confirmation of numerical models in the earth sciences. *Science* 263: 641–646.
- Osborn and Associates. 1993. *The Prospect for Institutional Arrangements to Promote Integrated Coastal Zone Management*. Coastal-Zone-Inquiry, Resource Assessment Commission, Australia.
- Papadakis, E. 1996. *Environmental Politics and Institutional Change*. Cambridge University Press, Cambridge, U.K.
- Peters, R.H. 1991. *A Critique for Ecology*. Cambridge University Press, U.K.
- PMSEC [Prime Minister's Science and Engineering Council]. 1995. *Sustaining the Agricultural Resource Base*. Australian Government Publishing Service, Canberra.
- Pownall, P. (ed.) 1994. *Australia's Northern Prawn Fishery — the first 25 years*. NPF 25, Cleveland, Australia.

-
- Preston N, Macleod I, Rothlisberg P, Long B (1996). Environmentally sustainable aquaculture production—an Australian perspective. In Hancock DA, Smith DC, Grant A, Beumer JP (eds). *Developing and sustaining world fisheries Resources: the state of science and management*. 2nd World Fisheries Congress proceedings. pp 471–477.
- QCC [Queensland Conservation Council]. date accessed 12/1/1998. *homepage* [Web Page]. Available at: <http://www.qccqld.org.au/>
- QFMA [Queensland Fisheries Management Authority] (1997). *Annual Report*. QFMA: Brisbane.
- Raaymakers, S. 1996. Shipping and ports. In: Zann LP (compiler). *The State of the Marine Environment Report for Australia. Technical Summary*. Great Barrier Marine Park Authority, Townsville, Australia. pp. 202–208.
- RAC [Resource Assessment Commission]. 1993. *Coastal Zone Inquiry Final Report*. Resource Assessment Commission, Canberra.
- Rayment, G.E. and Barry, G.A. 1993. Heavy metals: toxicity, chemistry and loading rates, in Fergus, I. F. and Coughlan, K. J. (eds) *Environmental Soil Science*. Australian Society of Soil Science Incorporated, Queensland Branch, Brisbane.
- Reed, M. G. 1994. Locally responsive environmental planning in the Canadian hinterland: a case study in northern Ontario. *Environmental Impact Assessment Review* 14: 245–269.
- Renn, O., Webler, T. and Wiedemann, P., eds. 1995. *Fairness and Competence in Citizen Participation: Evaluating Models for Environmental Discourse*. Kluwer, Dordrecht.
- Reynolds, M. and Lavery D. 1997. *The Great Divide—Northern Australia v's Southern Australia: a comparative social profile*. North Australia Social Institute, James Cook University, Townsville.
- Robertson, G. 1994. A national rangeland management strategy, in *Proceedings of ABARE's National Agricultural Outlook Conference, Outlook 94*. Australian Bureau of Agricultural and Resource Economics, Canberra.
- Rose, D.B. 1995. *Country in Flames: proceedings of the 1994 symposium on biodiversity and fire in north Australia biodiversity paper No. 3*. Biodiversity Unit, Commonwealth Department of Environment Sport and Territories and the North Australia Research Unit, Australian National University, Canberra.
- Ross, H. 1990a. Opportunities for Aboriginal participation in Australian SIA. *Impact Assessment Bulletin* 10 (1): 47–75.
- Ross, H. 1990b. Progress and prospects in Aboriginal social impact assessment. *Australian Aboriginal Studies* 1: 11–17.
- Roth, C., Aldrick, J., Ash, A., Hook, R., Novelly, P., Orr, D., Quirk, M., and Sallaway, M. 1998. *Catchment Management, Water Quality and Nutrient Flows as they Relate to the Northern Beef Industry: MRC scoping study to identify appropriate catchments for NAP3-funded research*. CSIRO Land and Water, Townsville.
- Saalfeld, P.S. 1992. *Internal Report of a Survey of Donkey Populations in the VRD [Victoria River District]*. Conservation Commission of the Northern Territory, Darwin.
- Sattler, P.S. 1993. Towards a nationwide biodiversity strategy: the Queensland contribution. In: Moritz, C. and Kikkawa, J. (eds) *Conservation Biology in Australia and Oceania*. Surrey Beatty & Sons, Chipping Norton.
- SCFA [Standing Committee on Fisheries and Aquaculture] Working Group on Aquaculture. 1994. *National Strategy on Aquaculture in Australia*. Canberra: DPIE Fisheries Policy Branch.
- SCFA [Standing Committee on Fisheries and Aquaculture]. 1998. *Research Priorities for Australian Fisheries and Aquaculture*. Standing Committee on fisheries and Aquaculture, Canberra.
- SEAC [State of the Environment Advisory Council]. 1996. *Australia: state of the environment 1996*. Department of Environment Sports and Territories, Canberra.
- Sherrard, J. 1998. Rising ground water—potential problem. In: *The Environmental Symposium: the issues facing the Ord today*. Ord Land and Water, Kununurra.
- Siewort, R. 1998. Conserving Environmental Values of the Ord. In: *Ord Land and Water: issues facing the Ord today. proceedings of a symposium*. Ord Land and Water, Kununurra.
- Smyth, D. 1996. Aboriginal maritime culture. In: Zann LP (compiler). *The State of the Marine Environment Report for Australia. Technical Summary*. Great Barrier Marine Park Authority, Townsville, Australia. pp. 104–111.
- Smyth, D. 1997. *Socio-cultural Considerations Issues Paper 6: socio-cultural saltwater country Aboriginal and Torres Strait Islander interest in ocean policy development and implementation*. Environment Australia Portfolio Marine Group, Canberra.
-

-
- Somers, I. 1994. No resource, no fishery: prawns and their habitat. In, *Australia's Northern Prawn Fishery — the first 25 years*. Edited by P.C. Pownall, NPF 25, Cleveland, Australia, pp. 49–65.
- Sproats, K. and Kelly, A. 1998. *The Role of Local Government in Natural Resource Management: discussion paper*. Local Government and Shires Associations of NSW, Australia.
- SRDC [Sugar Research and Development Corporation]. 1997. *Annual Research and Development Program 1997/98*. SRDC, Brisbane.
- Sullivan, P. 1995. *Beyond Native Title: multiple land use agreements and Aboriginal governance in the Kimberley*. Discussion Paper No. 89, Centre for Aboriginal Economic Policy Research, ANU, Canberra.
- Syme, G.J., Butterworth, J.E., and Nancarrow, B.E. 1994. *National Whole Catchment Management: a review and analysis of process*. Land and Water Resources Research and Development Corporation Occasional Paper 01/94, LWRRDC, Canberra.
- TFRNMVAWA [Task Force for the Review of Natural Resource Management and Viability of Agriculture in Western Australia] 1997. *Draft Report*. WA Ministry for Primary Industries, Perth.
- Thackway R. and Cresswell I.D. 1995. *An Interim Biogeographic Regionalisation for Australia: a framework for setting priorities in the National Reserve System Cooperative Program*. Reserves Systems Unit, Australian Nature Conservation Agency, Canberra.
- Thackway R. and Cresswell I.D. (eds) 1998. *Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments*. Environment Australia, Canberra.
- Tohill, J.C. and Gillies, C. 1992. *The Pasture Lands of Northern Australia: Their Condition, Productivity, and Sustainability*. Tropical Grassland Society of Australia, St Lucia, Queensland.
- Transport WA and KDC [Kimberley Development Commission]. 1997. *Kimberley Transport Towards 2020*. Government of WA, Perth.
- Uphoff, N. 1986. *Local Institutional Development: an Analytical Outlook with Cases*. Kumarian Press, Connecticut.
- Vance, D.J., Haywood, M.D.E., Heales, D.S., Kenyon, R.A. and Loneragan, N.R. 1998. Seasonal and annual variation in abundance of postlarval and juvenile banana prawns, *Penaeus merguensis*, and environmental variation in two estuaries in tropical northeastern Australia: a six-year study. *Marine Ecology Progress Series* 163: 21–36.
- Vanclay, F.M. and Lawrence, G. 1995. *The Environmental Imperative: eco-social concerns for Australian agriculture*. Central Queensland University Press, Rockhampton, Queensland.
- Von Sturmer, J.R. 1984. Interpretations and directions, in Tatz, C. (ed) *Aboriginies and Uranium: consolidated report on the social impact of uranium mining on the Aboriginies of the Northern Territory*. Australian Institute of Aboriginal Studies, Canberra.
- WADLG [Western Australian Department of Local Government]. 1997. *Annual Report 1997*. WADLG, Perth.
- Walker, D. H. and Johnson, A. K. L. 1996a. Delivering flexible decision support for environmental management—a case study in integrated catchment management. *Australian Journal of Environmental Management* 3: 174–188.
- Walker, D. H. and Johnson, A. K. L. 1996b. NRM Tools: a flexible decision support environment for integrated catchment management. *Environment Software* 1: 19–24.
- Walker, D. H., Johnson A. K. L., and Bellamy A. J. 1997. Integrating R&D into decision-making for natural resource management in coastal northern Australia. CRCReef and GBRMPA, *The Great Barrier Reef: Science, Use and Management: a national conference*. Great Barrier Reef Marine Park Authority, Townsville.
- Walker, D.H., Johnson, A.K.L., Cottrell, A., O'Brien, A., Cowell, S.G., and Pullar, D. 1998. *GIS Through Community-based Collaborative Joint Venture: an evaluation of impacts in rural Australia*. Paper prepared for the NCGIA specialist meeting on "Empowerment, Marginalization, and Public Participation GIS", Available at: <http://bbq.ncgia.ucsb.edu:80/varenius/>
- Walker, J. and Reuter, D.J. 1996. *Indicators of Catchment Health: a technical perspective*. CSIRO, Australia.
- WAMA [Western Australian Municipal Association]. 1998. *Local Government and Natural Resource Management: Mechanisms Available for the Protection and Management of Bushland and Wetlands: Draft for Comment*. Perth: WAMA.
- Wasson, R. 1997. Run-off from the land to the rivers and sea. CRCReef and GBRMPA, *The Great Barrier Reef: Science, Use and Management: a national conference*. Great Barrier Reef Marine Park Authority, Townsville

-
- Wasson, R.J., Caltcheon, G., Murray, A.S., and Wallbrink, P. 1994. Sources of sediments in Lake Argyle, in Novelly, P. *Ord River Catchment: situation statement*. Unpublished report, Department of Agriculture, W.A.
- Westley, F. 1995. Governing Design: the Management of Social Systems and Ecosystems Management, in Gunderson, Lance H., Holling, C. S, and Light, Stephen S. (eds) *Barriers and Bridges to the Renewal of Ecosystems and Institutions*. Columbia University Press, New York.
- Wetlands Unit of the Environmental Biodiversity Group 1998. *Australia's International Migratory Birds Agreements*. <http://www.anca.gov.au/environm/wetlands/j-camba.htm>.
- Wilcox, D.G. and Cunningham, G.M. 1994. Economic and ecological sustainability of current land use in Australia's rangelands. In: Morton, S. R. and Price, P. C. (eds) *R&D for Sustainable Use and Management of Australia's Rangelands: proceedings of a national workshop and associated papers*. Land and Water Research and Development Corporation, Canberra.
- Williams, L. 1997. *Queenslands Fisheries Resources: Current condition and recent trends 1988–1995*. Information Series Q197007. The State of Queensland, Department of Primary Industries, Brisbane, Australia.
- Williams, N. and Johnston, R. 1994. 'Not passing through': Aboriginal stakeholders in the rangelands. *Rangelands Journal*, 16 (2): 198–205.
- Wilson, B.R. 1996. Marine conservation and marine protected areas in Western Australia. *The State of the Marine Environment Report for Australia. Technical Summary*. Great Barrier Marine Park Authority, Townsville, Australia. pp. 488–492.
- Winter, W. and Williams, J. 1996. Managing resources and resolving conflicts: the role of science. In: Ash, A. (ed) *The Future of Tropical Savannas: an Australian perspective*. CSIRO, Australia.
- Wolfe, J. 1993. *Who's Planning, Whose Plans? The DEET–ATSIC Aboriginal Community Development Planning Pilot Scheme*. North Australia Research Unit Discussion Paper 15:46, Darwin.
- WGA [Working Group on Agriculture] 1994. *National Strategy on Aquaculture in Australia*. Fisheries and Aquaculture Branch, Department of Primary Industries and Energy, Canberra.
- WRC [Waters and Rivers Commission] 1997. *State of the Northern Rivers*. WRC, Perth, WA.
- Young, E., Ross, H., Johnson, J., and Kesteven, J. 1991. *Caring for Country: Aborigines and land management*. Australian National Parks and Wildlife Service, Canberra.
- Zann, L.P. 1995. *Our Sea, Our Future: major findings of the State of the Marine Environment Report for Australia*. Great Barrier Reef Marine Park Authority, Townsville.
- Zann, L.P. 1996. *State of the Marine Environment Report for Australia: Technical summary*. Great Barrier Reef Marine Park Authority, Townsville.

Appendix A – Agencies Consulted

Commonwealth

- Agriculture, Forestry and Fisheries - Australia
- Department of Defence
- Bureau of Resource Sciences
- Indigenous Land Corporation
- World Wide Fund for Nature
- Australian Seafood Industry Council
- Australian Fisheries Management Authority
- National Resource Information Centre
- Environment Australia

Western Australia

- Aboriginal Affairs Department
- Agriculture Western Australia
- Department of Commerce and Trade
- Department of Conservation and Land Management
- Department of Environment Protection
- Department of Land Administration
- Department of Mines and Energy
- Department of Resources Development
- Fisheries Western Australia
- Kimberley Development Commission
- Kimberley Land Council
- Ministry for Planning
- Ord Development Council
- Shire of Wyndham–East Kimberley
- Western Australia Fisheries Industry Council
- Western Australia Conservation Council
- Western Australia Pastoralists and Graziers Association
- Western Australia Planning Commission
- Water and Rivers Commission
- Water Corporation
- Western Agricultural Industries
- HG Gardiner and Associates

Northern Territory

- Centre for Indigenous Natural and Cultural Resource Management
- Environment Centre Northern Territory
- Northern Land Council
- Department of Lands Planning and Environment
- Department of Mines and Energy
- Department of Primary Industry and Fisheries
- Northern Territory Fishing Industry Council
- CRC for the Sustainable Development of Tropical Savannas

Queensland

- Balkanu Development Corporation
- Cape York Land Council
- Carpentaria Land Council

-
- Cattlemen's Union
 - Century Zinc Limited
 - Department of State Development
 - Department of Families Youth and Community Care
 - Department of Communication, Information, Local Government and Planning
 - Department of Minerals and Energy
 - Department of Natural Resources
 - Gulf Local Authorities Development Association
 - Department of Primary Industries
 - Gulf ICM
 - Department of Premier and Cabinet
 - Mt Isa ATSIC Regional Council
 - Queensland Commercial Fishermen's Association
 - Queensland Conservation Council
 - Queensland Fisheries Management Authority
 - Queensland Minerals Council
 - Queensland Transport
 - United Graziers Association
 - North West Queensland Aboriginal Land Council
 - Ports Corporation

Appendix B – Guiding Questions for Stakeholder Interviews

Sustainable Development in Tropical Australia – Scoping Study

PART A – GENERAL

1. What do you see as the key natural resource planning and management issues in your area of interest?
2. What do you see as the major impediments to achieving effective natural resource planning and management?
3. What do you see as the factors that enhance natural resource planning and management?
4. What new information is needed to address issues in assisting natural resource planning and management?

PART B – ORGANISATION/INSTITUTION

1. What are your organisation's aims and objectives in planning and management of natural resources?
2. How is your organisation structured to achieve these?
 - a. What legislation, policies, protocols guide your role?
 - b. To what extent is your current structure working and where do you see the need for change?
3. Who are your clients?
4. What are the principal constraints that you face in fulfilling your role and how do you feel they could best be addressed?
5. To what extent do you rely on people outside your organisation and how?
6. Do you support local level activities (eg. Landcare)? If so, what and how?
7. Do you use geographic information systems or decision support systems in your work?

PART C – ARRANGEMENTS AND PRIORITIES FOR NRM

1. With regard to natural resource management in the region, what is your impression of the effectiveness of existing institutional arrangements?
2. Which other organisations do you interact with and how do you interact with them (eg. memorandum of understanding etc)?
3. What are your research priorities for natural resource management, issues and/or regions?

Regional Planning in the Gulf of Carpentaria

1. What do you feel are the key issues in development and resource management in the Gulf?
2. Can you summarise your organisation and its structure as they relate to planning and resource management in the Gulf?
3. What are your organisation's objectives in relation to strategic resource use planning in the Gulf?
4. Who or what does your organisation represent in planning and management in the Gulf?

Who are your clients? What responsibilities do you have to your clients? What powers are vested in you to meet those responsibilities?

Do you face any conflicts of interest or other issues in representing or servicing these clients?

5. How do you pursue these objectives? In other words, what is your organisation's specific role? Can you give examples of specific contributions to resource planning in the Gulf or similar contexts?
6. What resources do you have at your disposal for pursuing these objectives?
7. What are the principal constraints that you face in achieving your organisation's objectives and how do these constraints impact on progress?
8. How do you feel that these constraints could be best tackled?
9. What is your overall impression of the institutional arrangements for resource management in the Gulf?
10. What is your impression of: 1. GLADA, 2. The GRDP, 3. The proposed MUSP, 4. The proposed Social Impact Assessment initiative
11. We are interviewing the following list of individuals and groups in relation to resource management in the Gulf

Are there any key players that are missing from this list? What is your organisation's relationship with these groups and how do you communicate with them? What do you see as being the key constraints faced by the groups that you interact with closely?

Appendix C – Non Resident R&D

Non-resident R&D relevant to integrated resource management in the study region.

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Agriculture								
Sugar	Development and testing of methods for evaluating environmental and economic impact of land use change and related infrastructure development in the sugar industry	1996–2001	<ul style="list-style-type: none"> Evaluate the spatial and temporal changes in catchment level agricultural activities and to characterise the changes in land use patterns with particular reference to Australian sugar industry. Assess the effectiveness of current natural resource management policies and practices as it relates to the sugar industry activities. Design a framework that provides for the assessment of environmental and economic trade-offs associated with sugar industry developments, focusing on land use planning. Develop and test analytical tools and methods for the catchment level assessment of environmental and socio-economic implications of land use change, to facilitate natural resource policy, planning and management in the sugar industry within a regional context. 	Herbert River Catchment Noosa/Maroochy/Mooloolah Catchments	CRC for Sustainable Sugar Production CSIRO Tropical Agriculture QDNR	Dr A Johnson	CRC for Sustainable Sugar Production	\$440,000
	Improved integrated resource use planning in the Australian sugar industry	1998–2001	<ul style="list-style-type: none"> To develop and test improved tools to support natural resource planning for the sugar industry. To identify mechanisms to enable stakeholder groups to implement negotiated approaches to integrated resource use planning in the sugar industry within a planning systems framework. To provide a range of improved approaches to facilitate integrated resource use planning across the Australian sugar industry. 	Herbert River Catchment Noosa/Maroochy/Mooloolah Catchments	CSIRO Tropical Agriculture	Dr A Johnson	Sugar R&D Corporation Sugar CRC Land and Water R&D Corporation	\$405308
	Improved techniques for the development and extension of sustainable cane farming systems	1999	<ul style="list-style-type: none"> Identify, develop and evaluate sustainable production systems Identify future research and extension needs for development and implementation of sustainable sugarcane farming systems Develop benchmarks and easily used performance indicators to monitor the farming system sustainability To establish and evaluate a participatory research and extension process. 	Northern Queensland	Bureau of Sugar Experiment Stations	Mr JS Milne Ms I Christiansen	Sugar R&D Corporation	Not Available
Cotton	Assessment of the relationship between riverine endosulfan levels and the degree of cotton development in river valleys of northwest New South Wales	1997	<ul style="list-style-type: none"> Provide detailed understanding of the relative contribution of environmental factors (total crop area planted, riparian crop area planted, average pest pressure, average number of endosulfan sprays, rainfall, wind) to the presence of endosulfan residues in surface waters of north west New South Wales. 	Macquarie, Namoi and Gwydir River valleys	New South Wales Department of Land and Water Conservation	Mr B Cooper	Land & Water Resources R&D Corporation	\$16,010

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Cotton	Regional validation and implementation of <i>Heliothis</i> population dynamics model	Not Available	<ul style="list-style-type: none"> To complete development of a regional model of <i>Heliothis</i> population dynamics (HEAPS) To implement a regional forecasting system for cotton growing areas using HEAPS to provide short-term predictions of <i>Heliothis</i> abundance To use the HEAPS model to investigate the impact of changing agronomic, climatic and biotic features of cotton cropping systems To use the HEAPS model as the basis for a broadscale spatial insect model. 	Northern NSW, Darling Downs	CSIRO Entomology	Mr M Dillon Dr GP Fitt	Cotton Research and Development Corporation	Not Available
Production	Development of practical indicators of sustainable agricultural production systems	1996–1998	<ul style="list-style-type: none"> Quantify the production, economic and environmental parameters of conservation oriented and conventional farming systems Establish benchmark criteria for sustainable farming systems and derive practical indicators of sustainability. 	Wheatbelt WA	Agriculture WA CSIRO Land and Water; WA Department of Land Administration; Murdoch University	Dr RA Nulsen	Grains R&D Corporation	Not Available

Environment/Biodiversity

Biodiversity	Biodiversity and evolution of the Australian flora	1982–1998	<ul style="list-style-type: none"> To determine the biological diversity, distribution, relationships and genetic systems of native genera and species of the Australian flora. 	National	CSIRO Plant Industry CRC for Tropical Rainforest Ecology and Management	Dr JJ Burdon Dr T Hartley Dr B Hyland Dr JG West Dr A Young Dr B Barlow Mr I Brooker	Not Available	Not Available
	Freshwater biodiversity	1993–2000	<ul style="list-style-type: none"> Focus on freshwater ecosystems as catchments of tropical rainforests and brings together and expands studies on high biodiversity streams, dispersal of biota between streams and fish species diversity. 	Not Available	James Cook University Centre for Catchment and In-Stream Research Queensland Department of Primary Industries	Assoc Prof RJ Pearson Mr P Clayton Mr Z Rosser Prof AH Arthington Dr J Hughes Dr B Pusey	Land & Water Resources R&D Corporation; Wet Tropics Management Authority	Not Available

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Estuary	National framework for the management of Australian estuaries	1998–2000	<ul style="list-style-type: none"> Assess the estuary management process in Australia, including the roles of integrated catchment management, ecologically sustainable development, planning initiatives, the strategic direction of estuary management, competing legislation, and impacts of actions resulting from management frameworks on estuarine quality Discover the dominant cultures of estuary management and how these cultures interact and effect estuary management Predict potential life cycles of community and institutional structures for estuary management Develop a conceptual framework for integrated estuary management. 	National	University of New South Wales School of Geography	Dr M Sant Mr T Smith Prof B Thom	Land & Water Resources R&D Corporation	\$121,463
Conservation	Building conservation strategies from stakeholders' intrinsic and social values	1997–1999	<ul style="list-style-type: none"> Identify and describe the intrinsic and economic values stakeholders place on native vegetation in agricultural landscapes Measure the relative importance of these values in stakeholders' judgements about the desirability of retaining and managing remnant native vegetation Identify the implications of this assessment for the formulation of strategies for collaboration between stakeholder groups to retain and manage RNV on agricultural land Canvas the views of a wide range of stakeholders on these implications to assist agencies to develop programs for managing RNV on agricultural land with stakeholder support. 	Not Available	University of New England Rural Development Centre	Mr GW Kaine Ms JL Sandall Mr IJ Reeve Dr R Cooksey	Land & Water Resources R&D Corporation Environment Australia University of New England	\$391,059
	Systematic entomology in conservation management	Not Available	<ul style="list-style-type: none"> To provide data on the identity, distribution, and biology of insects and related arthropods for application to the design and management of certain National Parks and other conservation areas. 	Not Available	CSIRO Entomology	Dr ES Nielsen	Not Available	Not Available
Riparian Management	Rehabilitation and management of riparian lands: ecological issues (Program B)	1994–1999	<ul style="list-style-type: none"> Identify key processes by which riparian zones influence in-stream ecosystems and their functioning, and quantify major effects. 		Centre for Catchment and In-Stream Research CRC for Catchment Hydrology	Dr SE Bunn	Land & Water Resources R&D Corporation	Not Available
	Rehabilitation and management of riparian lands: aspects of physical and chemical processes	1994–2000	<ul style="list-style-type: none"> To identify and quantify the effectiveness of riparian vegetation in modifying the: – surface and subsurface fluxes of water through the riparian zone – ingress of sediments and nutrients to the channel network – erosion and sedimentation of channels – conveyance of flood waters through the channel network. 	Johnstone River Catchment, Fitzroy River Catchment	CRC for Catchment Hydrology CSIRO Land and Water Queensland Department of Primary Industries	Dr I Prosser Dr P Hairsine Dr I Rutherford	Land & Water Resources R&D Corporation Queensland Department of Primary Industries	\$1,714,000

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Water	Evaluation of different measurement and modelling techniques for comparing deep drainage under current and alternative farming systems	1995–1999	<ul style="list-style-type: none"> Provide understanding, skills and tools to measure and predict deep drainage under farming systems for use across Australia Quantify the effects of farm scale management strategies on long term cumulative deep drainage to groundwater Identify and recommend ‘best practice’ agricultural strategies to minimise deep drainage and maximise water use and productivity. 	Loddon–Campaspe Catchment Liverpool Plains Catchment Upper Burdekin Catchment	CSIRO Land and Water CSIRO Tropical Agriculture Victorian Centre for Land Protection Research Queensland Department of Primary Industries	Dr J Williams Dr BA Keating Mr D Schroder Mr J Taylor	Not Available	Not Available
	Equity and other social implications in the allocation of groundwater for sustainable management	1988–2000	<ul style="list-style-type: none"> Determine allocation and sustainable management principles for groundwater that are perceived by the users to be fair and equitable Investigate the role of history of use (non use), prior rights and cultural background in perceptions of fair and equitable (re)allocation Investigate perceived fairness of ‘viability base’ allocation below which allocations will not be reduced, and processes to determine this Investigate the feasibility of providing alternative water sources as a method to reduce groundwater use. 	NSW	CSIRO Land and Water Australian Research Centre for Water in Society	Ms BE Nancarrow	Land & Water Resources R&D Corporation	\$130,954

Fisheries/Marine

Aquaculture	The impact of prawn farm effluent on coastal waterways	1997–2000	<ul style="list-style-type: none"> Quantify the assimilative capacity of the receiving environment for the major nutrients and sediments in prawn farm effluent and thereby determine the environmental impact of prawn farm effluent. 	Hinchinbrook Channel and Port Douglas	Australian Institute of Marine Science	Dr DM Alongi Mr LA Trott	Fisheries R&D Corporation	Not Available
Assessment	Tropical resource assessment program: development of models describing stock dynamics and exploitation in north Queensland fisheries	1995–2000	<ul style="list-style-type: none"> Provide management input in the form of options to achieve sustainable levels of harvest, desirable species mix in the harvest, and allocation of resources. 	Not Available	Queensland Department of Primary Industries QDNR; CSIRO Tropical Agriculture	Dr N Gribble	Fisheries R&D Corporation	Not Available
Management	Dynamics of large sessile seabed fauna, important for structural fisheries habitat and biodiversity of marine ecosystems, and use of these habitats by key finfish species	1997–2001	<ul style="list-style-type: none"> Determine the dynamics of structurally dominant large seabed habitat organisms important for demersal fisheries habitat and biodiversity of the seabed environment, in a tropical region Model the dynamics of seabed habitat and predict the potential of trawled grounds to recover as prime fisheries habitat Document the ecological usage of living epibenthic habitat by key commercial finfish species Assess three fishery independent and ‘environmentally friendly’ techniques for surveying tropical finfish resource abundance in inter reef areas. 	Great Barrier Reef	CSIRO Marine Research Australian Institute of Marine Science Queensland Museum	Dr R Pitcher Dr PJ Doherty Dr JNA Hooper	Fisheries R&D Corporation CSIRO Australian Institute of Marine Science Queensland Museum	\$1,108,944

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Management	Development of a rapid assessment technique to determine biological interactions between fish and their environment, and their role in ecosystem functioning	1996–1998	<ul style="list-style-type: none"> Ascertain the potential of functional morphology to provide rapidly and efficiently the information on species interactions, habitat use, and susceptibility to fishing gears, that is essential to fishery management using ESD principles. 	South East Fishery	CSIRO Marine Research	Dr N Bax Dr A Williams	Fisheries R&D Corporation	Not Available
	Issues affecting the sustainability of Australia's freshwater fisheries resources and identification of research strategies	1997–1999	<ul style="list-style-type: none"> Identify the key issues facing the sustainability of Australia's freshwater fisheries resources and suggest strategies for addressing those of highest priority Identify major threats to sustainability of freshwater fisheries resources in each State and Territory and the probable primary causes of the most significant To propose a national strategy for coordinating and funding new research relevant to ensuring the sustainability of Australia's freshwater fisheries resources. 	Nationwide	University of Canberra, Faculty of Applied Science	Prof RE Kearney	Fisheries Research and Development Corporation	\$228,147

Human and Social Services

	Culture, nature and environmental management in Central Australian rangelands	1996–1999	<ul style="list-style-type: none"> Analyse response of diverse rangelands users and managers to changing rangelands evaluations Evaluate the implications of these responses for the achievement of ecologically sustainable use of rangelands Develop a framework/process whereby the expectations and values of users can be incorporated into regional planning To develop and use methodologies for reflexive and responsive social research in the rangelands. 	Not Available	University of New South Wales University College, Australian Defence Force Academy, Department of Geography and Oceanography	Dr K Anderson Mr N Gill	Land & Water Resources R&D Corporation	\$75,000
	Environmental, economic and demographic factors and the viability of country towns	Not Available	<ul style="list-style-type: none"> Study of the long-term effects of drought, recession, commodity price dependence and demographic events on the economic and social viability of inland country towns The central western area of New South Wales is taken as a case study region, but a wider analysis of trends in equivalent areas of other States is being undertaken. 	Forbes, Parkes, Grenfell, Canowindra, Orange NSW	University of New South Wales	Assoc Prof IH Burnley	ARGC New South Wales Department of Planning	Not Available

Inter - Sectoral

	Applying management principles in variegated landscapes: identifying production–conservation tradeoffs	1996–2000	<ul style="list-style-type: none"> Examine the nature and scope of potential tradeoffs between production and resource conservation on grazing properties in subtropical woodlands and identify barriers to, and opportunities for, management strategies which optimise production and conservation. 	Crows Nest QLD	CSIRO Tropical Agriculture QDNR QDEH	Mr ND MacLeod	Land & Water Resources R&D Corporation Environment Australia	\$292,559
--	--	-----------	--	----------------	--	---------------	--	-----------

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Inter Sectoral	Citizens' Juries for environmental management	1999–2000	<ul style="list-style-type: none"> Investigate the potential of the Citizens' Jury to inform social decision-making about resource and environmental management, and compare it with standard valuation approaches Investigate the perceived usefulness of the Citizens' Jury to actors in the social decision-making process Establish guidelines for the use of the Citizens' Jury in environmental management. 		<p>Australian National University Research School of Social Sciences, Urban Research Program</p> <p>Centre for Resource and Environmental Studies</p> <p>University of Strathclyde</p>	<p>Dr RK Blamey</p> <p>Mr S Neimeyer</p> <p>Ms RF James</p> <p>Mr M Common</p>	Land & Water Resources R&D Corporation	\$172,650
	Making decisions for agricultural sustainability: scale as a critical influence	1997–2000	<ul style="list-style-type: none"> Assess the ecological sustainability and durability of management decisions at Landcare, catchment, regional and State scales Evaluate 'sustainability' across and between scales Determine the different ways in which economic and social justice concerns are addressed at each scale Document the needs and wants influencing decisions at each scale and explore similarities and differences across scale Determine the extent of community involvement in decision-making and if cultural identity is protected Develop methods for community monitoring and initiating changes, for improving land management sustainability of at different scales. 	<p>Avon WA;</p> <p>Blackwood WA;</p> <p>Kent WA; Wilson Inlet WA;</p> <p>Denmark River</p>	<p>Murdoch University, School of Biological and Environmental Sciences</p>	Ms SF Jennings	Land & Water Resources R&D Corporation	Not Available
	Integrated information management system for catchment managers	1996–1999	<ul style="list-style-type: none"> To develop information management processes, a decision-making framework and associated decision tools capable of integrating social, behavioural, economic and biophysical information into a form useful for catchment and other resource managers. 	Not Available	<p>University of Queensland</p> <p>QDNR</p> <p>Centre for Integrated Resource Management</p>	<p>Dr B Hooper</p> <p>Dr R Shaw</p> <p>Dr D Gramshaw</p>	Land & Water Resources R&D Corporation	\$373,397
	Investment of programs and institutional arrangements for effective natural resource management	1996–1998	<ul style="list-style-type: none"> Establish principles for deciding appropriate sources and extent of investment required for managing natural resource issues Develop and recommend institutional arrangements to simplify the application of socially efficient resource management practices. 	Murray–Darling Basin	<p>Liverpool Plains Land Management Committee</p>	Mr JA McDonald	Land & Water Resources R&D Corporation	\$298,120

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Inter Sectoral	Patterns of sustainable use of rangelands in the 21st century	1996–2000	<ul style="list-style-type: none"> Develop a pattern of sustainable land use for the Western Division of New South Wales, and a strategy for achieving it by; explaining past and current determinants of land use, generating alternative land use scenarios; representing stakeholders values, and assessing their likely ecological, social and economic outcomes; working with stakeholders to reach agreement; designing institutional and policy structures to support outcomes Establish nationally applicable principles, social processes and methods for translating broad policies on sustainable resource use into operational programs. 	Western Division of New South Wales	CSIRO Wildlife and Ecology New South Wales Department of Land and Water Conservation	Dr N Abel Mr B Tatnell	Land & Water Resources R&D Corporation	\$700,558
	Regional environmental assessment and management: spanning scales and trading values	1996–1999	<ul style="list-style-type: none"> Understanding the changing social and environmental dimensions of regional environmental management in Australia Investigate alternative institutional structures for participation in regional decision-making, and barriers and opportunities for development of management frameworks which incorporate long term and regional perspectives. 	National	Centre for Resource and Environmental Studies CRC for Sustainable Development of Tropical Savannas	Ms CD Mobbs	Land & Water Resources R&D Corporation	\$75,000
	Regional resource use planning in rangelands: a Central Queensland pilot study	1997–2000	<ul style="list-style-type: none"> Identify how additional information, information technology, improved planning and greater community involvement could help achieve sustainable use and management of natural resources Evaluate tools and methods to assist the regional stakeholder groups to assess regional resource use options, including their social, economic, and ecological implications. Facilitate stakeholder negotiation and planning integration Evaluate project effectiveness and document principles, processes, and techniques for supporting regionally driven, integrated and negotiated approaches to resource use planning in other rangeland regions in Australia. 	Central Queensland	CSIRO Tropical Agriculture	Dr A Dale	Land & Water Resources R&D Corporation CSIRO Tropical Agriculture Queensland Department of Primary Industries/ QDNR	\$2,280,700
	Using choice modelling to estimate non market values	1996–1999	<ul style="list-style-type: none"> Develop an accurate, reliable and practical technique of estimating non market environmental values Explore divergences between private and social perceptions of value Describe how choice modelling could be incorporated into decision processes for the allocation and use of natural resources. 	Central NSW	University of New South Wales Australian National University University of Central Queensland	Prof J Bennett Dr R Blamey Mr M Morrison Mr J Rolfe	Land & Water Resources R&D Corporation Queensland Department of Primary Industries QDNR New South Wales National Parks and Wildlife Service	\$497,697

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Inter Sectoral	Do water trade policies achieve environmental and socio-economic goals?	1996–1998	<ul style="list-style-type: none"> Determine to which degree TWE improves the long term productive capacity, sustainable use, management and conservation of Australia’s land and water resources Establish the market value of water entitlements both as a commodity separate from the land to which it traditionally has been appurtenant and as one of the bundle of characteristics making up an irrigation farm Identify which factors determine the value placed on water by market participants Identify the likely structural changes and socio-economic impact in the irrigation communities generated by the introduction of TWE 	Irrigated farms in South Australia and Victoria	University of South Australia School of Law and Legal Practice	Dr J McKay	Land & Water Resources R&D Corporation Goulburn Murray Water Victorian Department of Natural Resources and Environment Murray–Darling Basin Commission	\$3,000
	Effective planning procedures for ecologically sustainable land use in the rangelands	1995–2000	<ul style="list-style-type: none"> Define relationships between various land use practices and ecological, economic and social outcomes at appropriate spatial and temporal scales Determine the projected ecological, economic and social outcomes of existing patterns of land use in the absence of planning land use changes Develop procedures to integrate ecological, economic and social considerations, and meet established policy requirements, in order to provide land use allocations Develop procedures for representing and involving all stakeholders in regional land use planning Determine the political, institutional, market and fiscal intervention required to implement desired land use allocations, and to encourage enabling processes Determine the costs and benefits flowing from proposed interventions Work with stakeholder s in two rangeland regions of WA to identify ecologically sustainable land use patterns, and to assist the groups in implementation of changes in land use. 	National	Agriculture WA	Mr A Holm	Land & Water Resources R&D Corporation Agriculture WA Arid Lands Coalition CSIRO Wildlife and Ecology, Land and Water WA CALM	\$1,924,400
Grazing Systems	Coping with rainfall variability in tropical savannas	1996–2007	<ul style="list-style-type: none"> Compare and demonstrate the ability of different grazing management strategies to cope with rainfall variability in terms of their effects on pasture condition, animal production, economic performance, soil loss and biodiversity Develop, in conjunction with graziers, practical and sustainable grazing management strategies to assist producers in coping with rainfall variability. 	Dalrymple Shire, Queensland	Queensland Department of Primary Industries	Dr PJ O’Reagain	Not Available	Not Available

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Grazing Systems	Determining how livestock grazing and military training activities affect long term sustainability of tropical savanna ecosystems	Unknown–1999	<ul style="list-style-type: none"> To develop working models of the impacts of grazing and military training activities on vegetation dynamics and soil processes To produce recommendations on what, where and how to monitor military and grazing use. 	Townsville Field Training Area	CSIRO Tropical Agriculture James Cook University CSIRO Wildlife and Ecology	Dr AJ Ash	Department of Defence Land & Water Resources R&D Corporation	\$345,000
	Development and adoption of sustainable management systems	1997–1998	<ul style="list-style-type: none"> Identify approaches/strategies for increasing availability, awareness and use of sustainable and profitable grazing systems. 	Charters Towers	Queensland Department of Primary Industries	Mr MF Quirk	CRC for Tropical Savannas	Not Available
	Dynamic interactions between indices of farm profitability and sustainability	1995–1998	<ul style="list-style-type: none"> Develop indices of sustainability for livestock farming Develop dynamic measures that incorporate both the ecological and economic characteristics of farm systems Demonstrate that the sustainability of a farming enterprise can be described by a set of measures that reflect interactions between biophysical and economic system components of farms. 	Not Available	University of New England Rural Development Centre	Mr GW Kaine	Rural Industries R&D Corporation Land & Water Resources R&D Corporation	Not Available
	Coordinated pasture evaluation in northern Australia	1986–1999	<ul style="list-style-type: none"> Help ensure the survival of our grazing industries by planning for essential future plant evaluation work in northern Australia. 	Not Available	Queensland Department of Primary Industries	Mr IB Staples	Meat and Livestock Australia	Not Available

Tourism

	A spatial model for planning environmental requirements and impacts of coastal tourism on the east coast	Not Available	<ul style="list-style-type: none"> Identify areas unsuitable for resorts for environmental, social or economic reasons. 	Eastern QLD	CSIRO Marine	Dr D. Die	Not Available	Not Available
	A framework for evaluating the benefits and impacts of nature-based tourism in Far North Queensland	Not Available	<ul style="list-style-type: none"> Utilise a modelling framework to allow a wide range of data to be used in evaluating the benefits and impacts of nature-based tourism including (eg qualitative judgements of knowledgeable industry operators). 	Douglas Shire	CSIRO Wildlife and Ecology	Dr P Walker	Not Available	Not Available
	Predictors of Regional Tourism Success	Not Available	<ul style="list-style-type: none"> Determine the important factors which promote growth of tourism in a region by comparing the history of 12 regions in eastern Australia. 	National	CSIRO Wildlife and Ecology Office of National Tourism.	Dr Dick Braithwaite and Dr Paul Walker	Not Available	Not Available

Sector / Focus	Project	Year	Focus	Location	Organisation	Contact (s)	Funding Agency	Amount
Tourism	Tourism futures to 2020	Not Available	<ul style="list-style-type: none"> The project aims to move both beyond the 2–3 year time scope of current econometric models and incorporate social and environmental considerations in a holistic assessment of the future facing the Australia tourism industry. By integrating a number of short-term sub-projects to produce a detailed estimate of the likely demand for tourism product in Australia. Examine the options for meeting potential tourism demand. This includes assessments of policy changes, investments in infrastructure and superstructure, and planning at national, State and regional levels. 	National	CSIRO Wildlife and Ecology Tourism Council Australia, Bureau of Tourism Research	Dr Dick Braithwaite	Not Available	Not Available
	Impact of sea level rise and storm surges on coastal resorts	Not Available	<ul style="list-style-type: none"> The aim is to provide better estimates of current and future probabilities of potentially damaging storm surges at selected resort locations. 	Gold Coast	CSIRO DWE, Gold Coast City Council, Queensland DTSBI	Barrie Pittock	Not Available	Not Available
	Rainforest tourism	Not Available	<ul style="list-style-type: none"> To ask basic social science questions concerning visitor experience and use of the rainforest in the wet tropics To assess the nature, extent and preferred style of Aboriginal involvement in rainforest tourism To develop tourism resource planning models for rainforest settings To describe and segment the markets which use the rainforest for recreational and tourism purposes To evaluate the current practices and test new interpretation activities in rainforest tourism 	Wet Tropics World Heritage Area, north QLD	James Cook University Departments of Tourism Tropical Environment Studies and Geography Psychology and Sociology	Prof P Pearce Dr A Birtles Mr P Valentine Dr G Ross	Wet Tropics Management Authority	Not Available